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Agricultural Mechanisation

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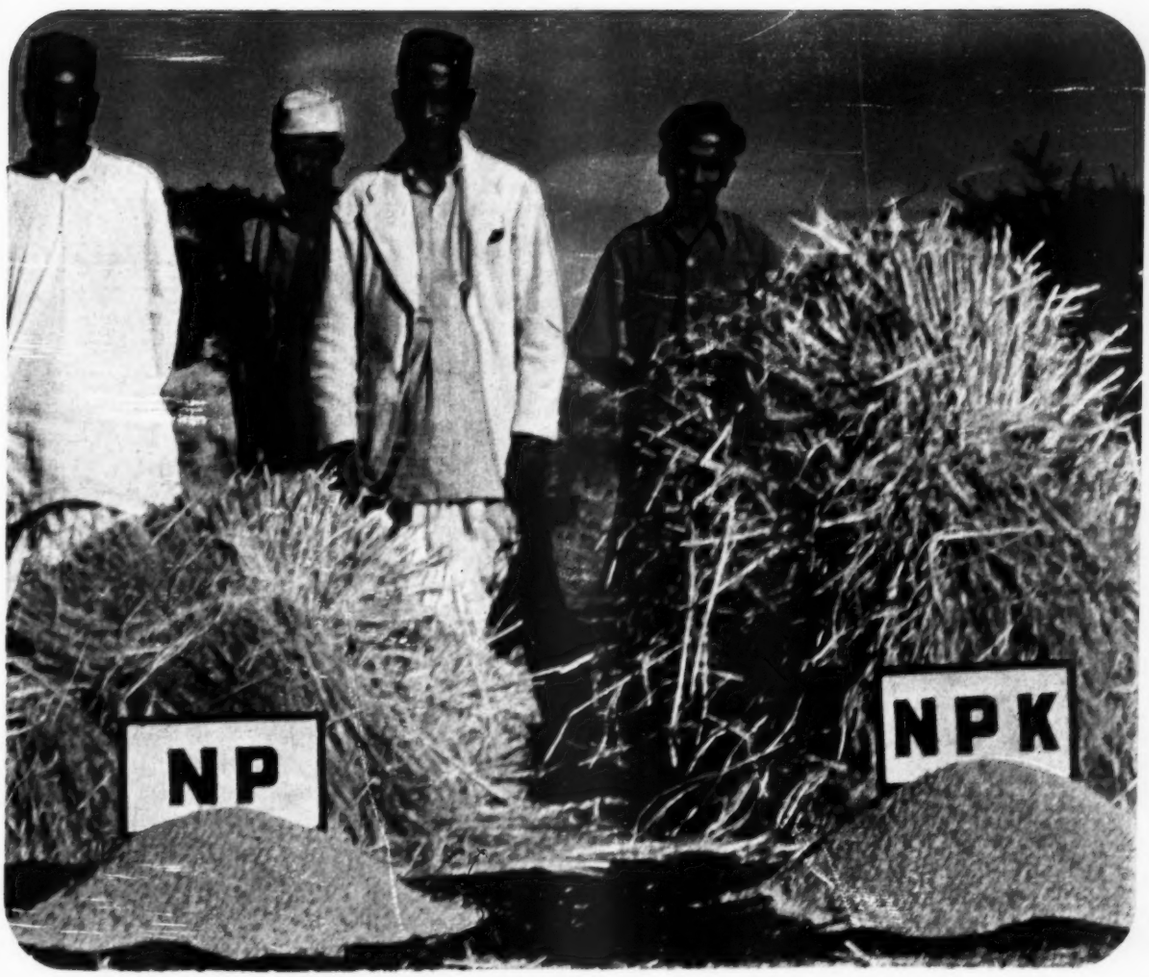

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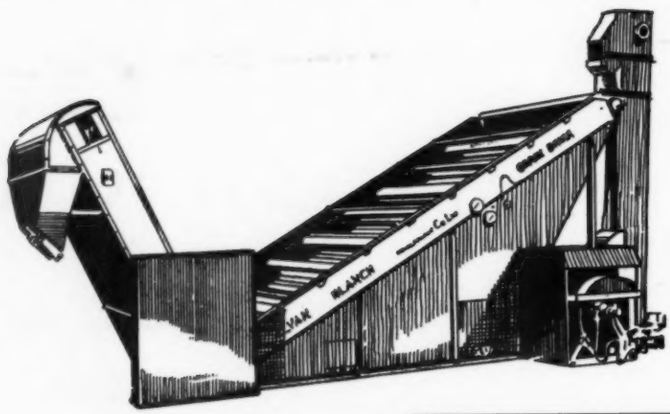

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Editorial Comment

Good news!

AT A TIME when prices and wage rates are still creeping steadily upwards, it is indeed good news to learn of price reductions. Subscription rates for 12 of the 15 Leonard Hill journals, including WORLD CROPS, have been reduced and the new rates, which are given on page 356, are to apply immediately to all new subscriptions and renewals.

In announcing very substantial reductions, Mr. Leonard Hill, the Chairman of the Group, says that they have been made possible by a general increase in circulations. The cuts, he adds, have been made to encourage this trend and so ensure the widest possible dissemination of technical information—an objective of vital importance today, when the world is changing so fast and it is increasingly difficult to keep pace with the March of Progress.

'It pays to advertise'

ACCORDING TO a statement just issued by the Agricultural Engineers' Association, Britain exported no less than 115,000 tractors during the past year. It is further stated that the future outlook is still more encouraging and that business to the value of £100 million sterling is expected in 1958.

It is fair comment that the bulk of this enormous total of tractors was produced and sent overseas by tractor manufacturers who are regular advertisers in WORLD CROPS – the International Journal of Agriculture . . . and what applies to tractor exports applies also to agricultural machinery, agricultural implements, agricultural chemicals and fertilisers.

Britain is making a real contribution to world peace by its down-to-earth policy of developing world agriculture—not in mere words, but in action. The future of world peace depends not so much on the possession of deterrent weapons as on the improvement of the economic position of under-developed countries.

The owner-cultivator—is he an anachronism?

THE ATTITUDE of mankind towards the possession of land has gradually changed through the ages and has altered radically in the most highly developed parts of the world over the past few decades. These changes can be correlated, first, with the development and degree of civilisation and, in later years, with the increase in population.

Before the dawn of history man followed his flocks and his herds, striking his tent when necessary and moving on to new grazing. Then cultivation in a primitive manner began, with the sowing of certain grass seeds, and during the later Stone Age of the Neolithic Period, between 1300 and 300 B.C., land was cropped for a year or two and then abandoned for fresh areas. This type of agriculture does not allow of population concentration nor of social progress. Yet even today, in this crowded world, it is reckoned that 200 million people, occupying 9,000 million acres of land, still follow the system of ' shifting cultivation '.

When settled agriculture began in Mesopotamia, the Nile and the Indus valleys, about 6,000 years ago, town settlements became possible and civilisation began. It is easy to appreciate how the cultivated lands soon fell into the possession of the few, and were generally tilled by serfs or slaves.

Then civilisation spread beyond the historic river valleys to southern Europe, whence, in due course, it reached Britain by way of Rome. The Romans had discovered much about farming which they taught to the early Britons, including the use of lime and of ashes, and the value of the third-year fallow. They introduced clover into Britain.

The centuries passed, the Romans departed, clover disappeared, the grain crop fell from 20 bushels per acre to less than 10, but there was still sufficient land to feed the people. Sooner or later in all countries the serf or slave rose against his overlord or the landowner, and in England he emerged from the Dark Ages to form the villein class who shared the produce of the land with his lord and held some of the land as his own. The village, under this so-called manorial system in medieval England, contained common meadows for hay and grazing, and fields for strip cultivation, in which every man, the lord, the freeman and the villein, had his share, small or large, although everyone was, perforce, subject to the general village policy as to cultivation of the common land and the strips. This was not a communistic society in the strict sense, but individualism was necessarily shackled. Beyond the ' fields ' lay the ' waste ' of marshes, heaths and forests, ever shrinking as hamlets and new fields extended, so that the hunter kings were forced to disgorge to their subjects one area after another.

The manorial system led England out of the Dark Ages. Then in 1348–49 came the Black Death, reducing the population total from 4 to 2½ million. As a result of the shortage of labour, freemen demanded higher wages and villeins demanded full freedom in return for 4*d.* per acre rent per annum instead of payment in the form of labour. Men asked that probing question:

> "When Adam delved and Eve span
> Who was then the gentleman?"

In 1381, Wat Tyler rose and was duly executed by the Mayor of London, but it made no difference. Serfdom in any form was finished and the villein became a small yeoman farmer or a free labourer for hire, or drifted

to the towns. He retained valuable rights in the open field or the waste, but he was free to go if he wished.

In Tudor and Stuart times the population had so increased that subsistence farming was no longer feasible and capitalistic agriculture began to take its place, with a definite increase in out-turn. These changes led, in the 15th and 16th centuries, to a partial enclosure of common lands and a marked improvement in the standard of farming. Hops and turnips were introduced into Britain, the feeding of cattle and sheep during the winter was studied, horses slowly replaced oxen at the plough and artificial grasses were introduced from Holland.

Halfway through the 18th century came the Industrial Revolution and the northern parts of England took on an importance in rivalry to the corn-bearing south and east. People flocked to the manufacturing centres, village industries atrophied, the common and waste lands were further enclosed so that more food could be grown. By the end of George III's reign in 1820 land enclosure was almost complete. The medieval system of open-field cultivation had become an anomaly in the face of increasing population. It was not till after the Napoleonic wars that Britain began to import grain in appreciable quantities, first from Russia, and later from America and the colonies.

Agriculture made a great leap forward during George III's reign, and ' Coke of Norfolk ', with the four-year shift, turned a sandy rabbit-warren into a model estate such as would have been impossible with the open-field system. In 1835 Lawes of Rothamsted began his study of cropping and of fertilisers, which in due course put Britain into the world lead agriculturally.

But the lot of the agricultural labourer was still a poor one, and the lines in Gray's *Elegy*, written in 1750—

> "The ploughman homeward plods his weary way
> And leaves the world to darkness . . . "

held even at the end of the 19th century. And such was his lot till the beginning of the present century.

Then came mechanisation. Today the tractor driver parks his machine at 5 *p.m.* sharp and goes off on his motor-scooter to the nearest town. On Saturday, at noon, he lines up for his substantial pay, with overtime. He may have no deep sentiment for the land, but he has the satisfaction of knowing that he has accomplished several times the amount of work achieved by the land-loving ploughman, and with a fraction of the effort.

And this must be the nature of farming in the future, not only in Britain, but everywhere. Procedure will be directed by some higher authority, as it is in England at present, and scientific methods will be compulsory. The U.S.S.R. has attempted to do this on the collective farm, but, judging by results, this system is a failure compared with what followed in other countries. Nevertheless, in Britain, with farms of 150 acres or less, some system of co-operative ownership and use of machinery is being increasingly employed, otherwise seasonal jobs cannot compete with those on large farms, where all types of machinery are economic.

In the light of what has been written, the FAO publication, recently issued by UNO, entitled ' The Owner-Cultivator and Progressive Agriculture ', seems to be out of step with present-day trends. This paper concludes that ' the merits and advantages of owner-cultivatorship become more impressive the deeper one enquires into the social structure and the mainspring of economic growth of agriculture '. It adds further, ' No other form of land tenure yet devised seems to elicit the willing and vigorous participation of the cultivator as does owner-cultivatorship '.

Centuries of experience in England run contrary to these conclusions. Man demands personal freedom, but that does not necessarily include freedom to misuse or under-use the land on which we all primarily depend. The world cries out for more food and still more food. There is no place for the subsistence farmer and, in view of the rocketing world population, there is no time to wait whilst the inefficient peasant owner learns to to pull his weight in an under-nourished world.

Economics of farm mechanisation

MORE AND more machinery is to be seen at agricultural shows every year, spotlighting the trend of modern farming. In only a very few years agricultural machinery has developed from primitive tools drawn by animals to the complex powered equipment of today. It has been estimated that one man controlling a 20-h.p. tractor can do as much as 200 men with hand tools and five times as much as a man with a team of horses.

Farm output in the United Kingdom today is about 160% of the pre-war figure, an achievement due in part to the developments in mechanisation over that period. Since 1939 the number of tractors in use on farms has increased tenfold, whilst similar striking advances have been recorded in the number of tractor ploughs, combine harvesters, milking machines, potato diggers, grain and grass driers and so on. As a result, the British farming industry is today the most highly mechanised in the world.

The annual machinery bill, including purchase and maintenance, is now about £200 million, an average of a little over £10 per acre for the 19-odd million acres under the plough. On the smaller properties the figure is much higher and has reached a disturbing level, for many of the machines are not operated long enough over the year to make their purchase an economic proposition. Perhaps half the machines on a farm have a seasonal use only, though the tractor, the ploughing and cultivating implements and the tractor trailer are, generally speaking, used in all months of the year.

The capital cost of machinery on a farm today varies according to the size of the property and ranges from about £40 per acre or more for the basic equipment of a

50-acre holding to £15 per acre or more on 1,000 acres. The point at which the economic limit is reached is perhaps about £25 per acre and farms under 100 acres would be well advised to fall back on a contractor for their marginal needs.

At the Seventh National Power Farming Conference, held at Cheltenham on 11–13 February this year, problems of the economics of mechanisation were considered and discussed. It was suggested that farmers of 150 acres or less, following the normal range of farming operations, should consider co-operative ownership and use of machinery. Otherwise carrying out small seasonal jobs could well be double that of the same operations on large farms or of concerns working on a co-operative basis. Some farmers may regard such a procedure as a step towards collective farming and may mistrust it on that account. Nevertheless, machinery syndicates are being formed in Britain and are operated under predetermined rates of ownership and use, and such systems are operating satisfactorily.

Farming at high altitudes

IT WILL be good news to the farmers of Kenya that a supercharger has now been designed which will make it possible for a standard tractor and agricultural vehicles to be used at heights of between 6,000 and 10,000 ft. with the same efficiency as at sea level. The cost of the attachment adds roughly £50 to the price of the tractor.

This will bring about a minor revolution in agriculture, as it will mean that millions of acres of inaccessible lands in all parts of the world hitherto untouched or only scratched can now be brought under the plough.

Record rice yields

THE RICE growing in the irrigation areas of the Murray and Murrumbidgee Rivers in New South Wales and Victoria is now giving bigger yields to the acre than in any other country in the world. Some fields are said to be yielding more than four tons per acre.

Rice growing is now one of Australia's most mechanised primary industries and bulk handling is expected to do away with the remaining small amount of manual operation. Growers are also experimenting with a new method of drying the rice by unheated air. We learn that this record yield was produced by a variety called Caloro II, developed from an American introduction.

Australian rice up to now has been a short-grained type similar to the varieties preferred by most European people, though Chinese and Indians prefer long, slender-grained rices. There is now under test a newly introduced American variety, Calrose, which is a compromise between Eastern and Western tastes, a semi-long grain, which has been milled successfully.

Since the dawn of civilisation, India and China have led the world in rice production, but the Australian rice industry has been making great strides in the last 30 years. For many years yield records were held by the U.S.A. and Spain. The industry in Australia got its first break in 1920, when a fruit-canning specialist made a study of methods in southern California. He noticed crops there on heavy land which strikingly resembled the Australian irrigation areas. He returned with 300 lb. of seed, which formed the nucleus of the new industry. Since then more than 1,000 varieties from many lands have been introduced successfully.

Farms in the dark

AGRICULTURE IS no longer a handicraft; the age of mechanised agriculture has arrived and the farmers of the world will soon need as much power as the heavy industries, if they are to continue to meet the full requirements of an ever-increasing world population. Mechanised agriculture does not merely involve the use of tractors, mechanised implements, mechanical sprayers and aeroplanes, depending on oil as a source of power; there are also stationary installations, such as crop and grain driers, processing machinery, heaters and coolers, equipment for producing artificial daylight and artificial rain, elevators and conveyors, milking machines and dairy equipment, for which more and still more electrical power will be required.

Yet it is true to say that, while the big cities of the world are glittering with electric lights and neon signs, the vast majority of the farmers of the world have still to be content with feeble kerosene lamps or wicks burning in molten fat, and it is little wonder that agriculture in many countries is more or less at a standstill; these countries are what is so correctly described as ' under-developed '. Farming needs oil and electricity for power and light as much as any other industry in the world. Why, therefore, talk of a trade recession when *there are still opportunities unlimited in world agriculture.*

Rehabilitation and replanting

THE PLANTATION industries of the tropics are now between 50 and 100 years old and are in need not only of replanting and rehabilitation, but also of further extension to meet the growing needs of an ever-increasing world population for more and more food and raw materials. It is essential that these industries should be recapitalised, but what assurance is there that such investments will be safe and reasonably rewarding in view of the instability of democratic government in the newly self-governing territories, where the method of conducting elections is often a travesty of democracy. In any case, a period of 10 years is barely sufficient time in which to begin to obtain a return for the expensive pioneer work of rehabilitating the soil and replanting new areas with such long-term crops as tea, rubber, coconuts, cocoa, coffee, sisal and oil palms.

The men who risk their capital and the men who execute these operations are entitled to a fair reward for such development work which will materially add to the prosperity of the countries concerned, but we have observed a growing reluctance to invest capital in countries where there is not a stable and responsible government which will honour its commitments, not only to companies, but also to foreigners serving those countries.

The time has perhaps come when all contracts of service and all international contracts involving the investment of capital should be registered at the International Court of Justice at The Hague, so that there could be an independent court of appeal against the irresponsible acts of acquisitive or defaulting governments and its decisions could be enforced by economic sanctions.

Replanting with confidence

MALAYA MAY regain her place as the leading producer of natural rubber, according to Mr. H. T. Karsten, a former chairman of the Rubber Growers' Association. He was very impressed by the progress made in replanting and thinks that as a result rubber production in that country will show a considerable increase during the next ten years as the young trees come into production. Last year Malaya produced 639,000 tons; he estimates that by 1968 production could reach as much as a million tons.

A tremendous effort has been made by the industry to meet the threat of the synthetic product. Replanting has not merely been a case of new plants for old; the opportunity has been taken to replace the senile rubber trees with budded trees, produced from high-yielding clones, in order to reduce the cost of production, so that natural rubber can command a larger share of the demand. Unfortunately, there must be a time lag and it may be difficult at present prices for estates, who have not yet completed their replanting programmes, to continue. With replanting costs equivalent to 10 to 12 cents for every pound of rubber produced, replanting operations may have to be curtailed. The wisdom of ploughing back profits during periods of high prices will be obvious not only for rubber, but for other plantation crops, such as coconuts and tea.

Delivering the goods

ALMOST ALL research bodies issue one or more periodicals embodying specialist articles recording the results of research work together with other matter likely to be of interest or value to various sections of the local community. The widest possible publicity needs to be given to completed research investigations, while the country or product which, directly or indirectly, finances the work is obviously entitled to the information so that they may be the first to reap the benefits of the discoveries.

A large number of agricultural journals which emanate from departments of agriculture and other research institutions contain articles of great importance, often mixed up with reprints, reports, simplified articles, notes, propaganda, snippits and tit-bits of trade and statistical information, directed to sections of the local population, but possessing no international importance. Such an arrangement provides no proper solution to the problem of local publicity, and furthermore the overseas circulation of such journals is often so small that not infrequently the results of important research work are overlooked. We believe the public would be better served by eliminating some of the more obscure journals, thereby strengthening the more important journals which exist for the express purpose of publishing original research work.

It is true that the wheat is separated from the chaff for the benefit of the scientist by various abstracting bureaux and journals, but although these abstracts are indispensable to the research worker they are no substitute for the original article. We believe, therefore, that many departments and institutions would be well advised to reconsider their publications policy and investigate the possibilities of amalgamation of publicity with neighbouring research bodies and institutes, insofar as highly scientific articles are concerned, or else submit them for publication in one of the recognised scientific journals. Such a course of action would secure world-wide recognition of their research work and make better use of financial resources of the Institute, in the better interest of the population they directly serve.

The ideal is publication of scientific articles in a scientific journal, simplified accounts of such work in a more popular journal and advisory leaflets for local circulation, in the languages of the country.

Nectar of the gods

A SURREY (England) firm which imports honey from the Caribbean, Israel, Greece, Argentina, New Zealand and Australia states that the honey from each country differs in flavour and colour and, according to Mr. Brian Shaw, a leading importer, honey from the blossoms of the leatherwood tree of Tasmania has a distinctive almond-like flavour which has an immediate appeal to those who are looking for something different.

Unfortunately the leatherwood tree is exclusive to Tasmania and supplies are limited, the actual amount available for export this year only amounting to some 20 tons. We do not know whether any reliable investigation has been carried out to compare the different flavours of honeys produced from different species of flowers as it would be difficult to control the bees in their search for nectar, but we would like to know if any of our readers have any views.

Tractor Populations and Agricultural Efficiency

DAVID CALCUTT
(*Agricultural Engineers' Association*)

DURING the post-war years a quiet revolution has been taking place throughout the world – the mechanisation of agriculture. The extent of this revolution ranges from the appearance of mechanical tea pluckers on the hills of Assam to work study of mechanical sheep shearing in Wales. It appears in Russia as the reclamation of vast areas of steppe, in China as the complete reorganisation of her agricultural system, in Venezuela as enormous irrigation schemes and in the small island of Britain as an aid to its farmers producing more food than is produced in the whole of Australia.

Systems of land tenure, traditional methods and age-old taboos are giving way under the pressure of modern machinery at a rate which varies not only from country to country but even under different landowners within the boundaries of a single community. While, with a few exceptions, machinery is available for all the major farming operations in the world, the range of those operations, the immense variety of crops, and considerations such as the availability of capital and labour all add to the difficulty of comparison. A comparison of tractor populations, while it is by no means an exact yardstick, should provide a basis from which the comparative efficiency of a nation's agricultural industry may be measured.

The common denominator

At first sight there appears to be no common denominator. In fact, the only one is the tractor which, being a basic requirement for all types of farm mechanisation, is universal. If, therefore, a country's tractor population can be related to the area of arable land available and to its crop production, a general indication can be obtained of the country's agricultural efficiency in at least one department. This can then be compared with the equivalent in other countries.

Statistics issued by F.A.O. show

The productive efficiency of agricultural industry and the ability to produce cheap food is directly related to the tractor population of a country

that, in 1956, the world tractor population then was of the order of ten millions, distributed as in Table 1.

It will be seen that nine million tractors were concentrated in three huge blocks – Canada and the U.S.A. had five and a quarter millions, Europe two and a quarter and the U.S.S.R. one and a half. At the other end of the scale Asia, excluding China and Japan, had only 96,000 tractors. The lack of tractors in Africa, Asia, Oceania and South America shows that it is those countries that have had some experience of industrialisation in other fields who are among the leaders in mechanising their agriculture.

Table 1
Tractor populations

Area	*Tractor population*
Canada and U.S.A. ..	5,257,000
Europe (excl. U.S.S.R)	2,341,000
U.S.S.R.	1,577,000
Oceania (incl. Australia)	295,000
South America (excl. Brazil)	189,000
Africa (excl. Belgian Congo)	182,000
Asia (excl. China and Japan)	96,000

Acres per tractor

When tractor populations are related to arable acreages, some surprising facts are revealed, as Table 2 shows.

The fact that mechanisation of agriculture has proceeded so rapidly in most of the countries of Western Europe may be attributed, in part at least, to their need to save foreign currencies. It is at the same time a clear indication of what can be done. Britain, for example, has only 11 million acres of arable land available and a farming labour force of only

Photo: Ford Motor Co. Ltd.

One more tractor for Europe. A 'Dexta' tractor destined for Antwerp, Belgium

520,000. Yet she produces sufficient wheat for 10 million of her 50 million people, barley and oats for 43 million, sugar for 11 million, and oils and fats for eight million. Despite the fact that the growth of other industries has reduced the amount of farm land available and that the number of workers has been reduced by 20% since the second world war, Britain is producing 60% more food than she did in 1939.

The picture in U.S.A. is almost one of stagnation. Her agricultural output has increased by only 6% since 1947 although, in the same period, her population has increased by 26,000,000. The latest available figures show her tractor production as 685,000 a year, of which almost 650,000 are absorbed by American farmers.

In the last 10 years over 4,000,000 Americans have left the land, and arable land, equivalent to the whole of the arable area of Britain, has been returned to grass. This retarding of arable production is entirely artificial and is part of a deliberate government policy to absorb the enormous food surpluses that American farmers produce. In spite of a smaller acreage and less manpower, the million extra tractors that have appeared on American farms in the last decade have helped to increase output per man-hour worked by a little over 30%.

West European countries that are having difficulty in other directions find those difficulties reflected in their tractor populations; France and Italy being two cases in point. France is now making great efforts to increase her imports of tractors and many of her fears for the European Free Trade Area are based on the inability of her agriculture to compete in Western Europe as a whole. The evidence now seems to show that the new administration is taking a much more realistic view of this.

India represents a striking example of the effect that tradition and land tenure systems can have on a country's food production potential. The answer that they have an almost endless supply of cheap labour and that tractors are not a business proposition for their farmers does not give a true picture. Indian rates of production are low, a high proportion of the population is permanently at starvation level but those government tractor stations which have been established, have brought an immediate increase in local farming prosperity.

TABLE 2
Tractor populations and acreage

Country	*No. of tractors*	*Arable acres per tractor*
U.K.	482,923	27
Luxemburg	5,018	40
W. Germany	461,660	43
Norway	37,000	55
Sweden	125,400	72
Belgium	65,973	85
Denmark	67,299	103
U.S.A.	4,600,000	103
Eire	30,902	123
France	425,000	125
Italy	168,307	240
Czechoslovakia	38,777	348
U.S.S.R.	1,577,000	350
Bulgaria	24,283	443
Hungary	25,483	567
Poland	51,112	792
Rumania	32,160	985
Argentina	57,800	1,298
India	18,446	21,460

But the transition from ploughing with a bullock-drawn stick to using and maintaining even a simple tractor is not one that can be made overnight in a free society, nor does this seem possible in a controlled society.

The belt of land covering the Danube Basin, the Vojvodine, the Ukraine, and the Volga is potentially the richest arable area in the world. It has plenty of water, a perfect climate and in some places a topsoil that is 100 ft. deep.

From those Russian production figures that are available, it would appear that as many as 120 million of her 200 million population are engaged in farming. Grain is produced in Britain at the rate of 17 tons per farm worker and the average for Western Europe is around 10 tons. In Russia owing, to use their own words, 'to more rational and scientific methods of farming' they have increased the yield of their chief grain crops to one and one-third tons per worker, but in spite of the advantages Russia has over Western Europe in terms of land, climate and labour, the arable production achieved by her thin tractor population is in inverse proportion to that of Western Europe.

A serious shortage of foreign currency and a threatened shortage of food forced the development of the tractor industry in Britain and an enormous investment has made her today the world's leading exporter of agricultural machinery.

Stop Press: New Subscription Rates!

Subscription rates for 12 of the 15 LEONARD HILL journals have been reduced in most cases by 33% or more, and with immediate effect for all new subscriptions and renewals.

The following six journals are reduced from £3 to £2 a year: 'Manufacturing Chemist,' 'Food Manufacture,' WORLD CROPS, 'Paint Manufacture,' 'Corrosion Technology,' and 'Atomics.' Other reductions are: 'Automation Progress' from £3 to 30s. a year, 'Petroleum' from £2 10s. to £2, 'Chemical and Process Engineering' and 'Fibres' from £2 10s. to 30s., 'Public Works and Muckshifter' from £2 to 30s., and 'Conferences and Exhibitions' from 30s. to 25s.

A new technical journal, 'Building Materials (Export),' which makes its debut in October, will cost 20s. per annum. 'Building Materials and Floors' remains at £2 and 'Dairy Engineering' at 30s. per annum.

A library or other organisation, subscribing to all journals, will thus find its total bill has been cut by no less than £10 15s. Further economies can be made by subscribing for three years and readers of WORLD CROPS can now obtain this journal for this period for only £5.

Facts and Fallacies about Mechanisation in India

PROF. PESTONJI N. DRIVER, M.A.
(Chair of Agricultural Economics, Poona, India)

In India there is still, in some quarters, considerable resistance to the machine, but during the past year the Government has stated that mechanisation has definitely established its usefulness to Indian agriculture.

THE mechanisation of agriculture is still regarded with apprehension in some quarters in India largely because of the spectre of unemployment. It is sound policy, so the argument goes, for a country which has an abundance of land and a scarcity of labour to talk of mechanisation, but where the reverse holds, one cannot accept this gospel.

Pros and cons

Mechanisation has certain known advantages. It saves labour, it saves time and it increases the area cultivable per man; it also increases output per acre by more timely and deeper cultivations. These advantages, however, are regarded by some as disadvantages when looked at in the light of conditions in India. It is held that our problem in India is not to save either labour or time, for we have more labour than we require. As to cultivating more acres per man, it is held that we have here more men than land and not more land than men.

The part-truth and part-fallacy of such arguments will be self-evident. There are two other advantages which are equally, if not more, important – machinery increases productivity per acre and also reduces the cost of production. This makes possible the cultivation of land which could not otherwise be cultivated economically. Machinery also saves time, so that it is possible to complete agricultural operations rapidly during short periods of favourable weather which might otherwise not be carried out, so that the land would be left fallow.

A bulldozer preparing land for cultivation in the ' Grow More Food ' campaign in India

The problem of mechanisation becomes more complicated than it need be because assertions have been made, by those who are opposed to co-operative and collective farming, that tractors do not increase yields and large-scale production cannot, and does not, really give us the economies claimed. That tractor-ploughing can by itself produce greater yields than laborious hand - cultivation has been amply proved.

More food or more work

Even where it is conceded in a general way that mechanisation means more economic production, the problem of unemployment still clouds the issue. What is happening in India appears to be happening also in comparable countries like China and Indonesia. Thus when we reach the stage of choosing between more food production (with consequent unemployment) and more employment (by resisting mechanisation) many people will support the second of the two alternatives. This is because the advantage of more production through mechanisation and the subsequent improved chances of solving unemployment is not so obvious as the more immediate political and sociological danger of unemployment.

We also overlook certain other aspects of mechanisation through this overriding fear of unemployment. Mechanisation does not only mean the use of tractors. We also require mechanisation for such indispensable necessities as the supply of water. The sinking of a tube-well or the installation of electric pumps or a diesel pump is a form of mechanisation without which we cannot have progressive agriculture and cannot begin to make effective use of fertilisers and manures.

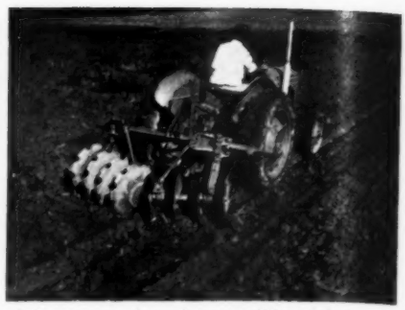
Mechanisation also makes it possible to bring more land under cultivation than is possible by the technique that has necessarily to be followed on small farms. Large tracts of our wastelands, which are uncultivatable by this technique (of the small wooden or iron plough drawn by a pair of bullocks), can be brought under the plough by mechanisation. Apart from this, mechanisation will add materially to the land available for food crops by releasing land at present needed for the production of fodder for draught cattle.

Livestock and farming

It is true that there are difficulties in the way of replacing farm cattle by machines in a country like India. There is strong opposition based on the

The heavy disk plough for work in a rocky terrain

Shallow ploughing with the mouldboard plough



The serrated and reversible disk harrow Note the lift of one set of blades

belief that livestock and farming are both inseparable and interdependent, and that the present situation – where cattle manure is available in adequate quantity and crops and their by-products are available as stock feed – is ideal. The fact is the replacement of animals by machines and the loss of farmyard manure has not led to any harmful effects at all in Britain – on the contrary.

It would be better if we realise that the replacement of man-power by machines requires more attention than the replacement of farm cattle. Machines can be used to replace draught cattle without causing serious human unemployment. The recent tendency to retain animal power and use it for driving small machines may, in fact, require reconsideration. It is good to have a stable policy of employment, but continuous resistance to mechanisation means throwing overboard the possibility of getting more cheap food per acre of land, *i.e.* more food per person, of an ever-growing nation.

Costs of Land Preparation in India in 1954

Capital outlay (in Indian rupees)

Tractor		Bullocks	
Tractor	Rs. 7,700/-	10 pairs of bullocks at Rs. 1,000/- per pair	Rs. 10,000/-
Implement	Rs. 1,325/-	10 bullock ploughs at Rs. 22/- each ..	Rs. 220/-
Extension wheels ..	Rs. 200/-		
Accessories	Rs. 175/-		
Total ..	Rs. 9,400/-	Total ..	Rs. 10,220/-

Operating cost (based on 100 acres wet paddy cropped twice yearly, total area to be puddled 200 acres. Ten pairs of bullocks will be required to complete the puddling in the same time as one tractor)

Tractor		Bullocks	
Speed: 1 acre in 2½ hours.		Speed: 1 pair – ⅓ acre daily.	
Labour:		Labour:	
1 driver at Rs. 2.8.0 for 62 days ..	Rs. 155/-	600 days at Rs. 1.8.0. (*i.e.* 10 drivers for 60 days)	Rs. 900/-
1 cleaner at Rs. 1.0.0 for 62 days ..	Rs. 62/-		
Fuel and oil:		Fuel and Food:	
500 gal. powerine ..	Rs. 875/-	600 days at Rs. 2.0.0 per pair	Rs. 1,200/-
31 gal. petrol ..	93/-		
15 gal. oil	112/8		
Incidentals	100/-		
Total ..	Rs. 1,397/8	Total ..	Rs. 2,100/-

No allowance is shown for depreciation since both animals and machine should be depreciated at the same rate.

Rice growers in Madras State, India, claim a rice yield increase of 25% to 30% on mechanically cultivated land over adjoining lands cropped at the same time, but prepared by bullocks.

Working in this same area with the mounted disk harrow and extension wheels used for puddling, one large-scale farmer reports preparing 150 acres in 150 hours' tractor work.

Abstracted from ' Rice ' – a Massey-Ferguson booklet circulated to members of the International Rice Commission Meeting, Tokyo, 1954.

The vital issue

The important issue is whether it is better to have more mechanisation, more food and more wealth with possibly some short-term unemployment, or plan for continuous employment, without mechanisation and with poverty and less food per person.

Too often in India we have been told to look at China and Japan with their large yields per acre, obtained in spite of the absence of large-scale farming and mechanisation, but a closer examination of the situation in these two countries is necessary. China has resisted so far any large-scale mechanisation, but, due to general poverty and pressure of population, farm cattle are even being replaced by human labour. Is this a happy prospect? Can we assure the people that we shall prohibit mechanisation in order to maintain employment, but that it is likely that, owing to the general poverty which will result, they may have to replace even their own cattle and become mere beasts of burden?

In the case of Japan, also, one wonders whether it will always be possible for that country to produce food as cheaply as she can get it from other countries abroad, where it is produced at a lower cost through large-scale mechanisation. In fact, even now we see the writing on the wall, for it has recently been reported that the Japanese felt that it would be cheaper to import rice from abroad rather than produce more of it at home at a heavy cost '.* The Japanese situation thus implies that the existence of small farms prevents pooling of lands and

*Report of the Indian Delegation to China on Agrarian Co-operation: p. 119.

The tractor being used for transporting agricultural produce in India

large-scale mechanisation. Thus it cannot help us even if we, like the Japanese, are prepared to use small agricultural machines.

It is becoming increasingly impossible to deny the advantages of mechanisation. It is often forgotten in dealing with the problem in its Indian context that mechanisation may take time, but any assumption that it has not come, cannot come, and will not come, is wrong. On the best farms all over the world, including India, we see clearly the tendency towards mechanisation. We cannot ignore the positive evidence of increasing mechanisation of world agriculture as proved by ever-increasing exports of tractors from Britain to over 100 countries.

In a world fast becoming overcrowded it is becoming impossible to stick to traditional ideas of the importance of individual farming. The overcrowded world of tomorrow will require greater experiments in joint farming and joint living because either we learn to live together or we perish separately. It is the same problem in agrarian life as in politics, and the sooner we all understand this the better for the world.

Photo p. 357 by the author; other photos by Massey-Ferguson Ltd.

Phosphorus in Agriculture

A one-day symposium organised by the Society of Chemical Industry in London

AN all-day meeting was held by the Agriculture Group of the Society of Chemical Industry, at which papers were presented dealing with the uptake and determination of phosphorus in soils. The chair was taken by Mr. A. G. Pollard in the morning and by Dr. H. L. Richardson in the afternoon. The following is a précis of two of the papers:

Measurement of Fertiliser Phosphorus Uptake and Radiation Damage Using Radio-Phosphorus. *by Mr. E. R. Armitage (I.C.I. Ltd.), Jealott's Hill Research Station.*

At Jealott's Hill they had used the tracer method for comparison with the usual difference method for phosphate uptake and had also compared dry matter yield. Phosphate uptake with three soils, an acid sandy (*p*H 5.3), a slightly acid (*p*H 6.0) and a calcareous type (*p*H 8.0) had been studied. Italian ryegrass and mustard were the crops used and with a dressing of 60 lb. P_2O_5 per acre three different levels of ^{32}P were used. Results were in general agreement for the 1954–55, 1955–56 seasons. No effect could be determined on plant growth by the use of ^{32}P compared with normal ^{31}P on visual growth or in germination and no significant difference could be determined for the two groups.

A study of the phosphate uptake by both the tracer method and the normal difference method showed that the difference method gave a significantly greater recovery on acid soil, but no significant difference on a slightly acid soil. There was a considerable discrepancy on the calcareous soil. The work indicates that radiation damage to a plant is slight provided no more than 2 mc. per g. of ^{32}P are present, but ^{32}P recovery yields are no more accurate than the final difference method for a measurement of phosphate uptake.

Organic Acids Produced in Farmyard Manure and their Influence on the Solubility of Soil Phosphate. *by I. J. Cooke (Fisons Ltd.), Levington Research Station.*

The influence of organic acids on the solubility of soil phosphate has frequently been considered, but very little work directed towards the identification of acids produced in soils by the decomposition of organic matter.

Farmyard manure, stored aerobically, was extracted with water and organic acids separated for characterisation by paper and anion exchange chromatography. Two acids were present in significant quantities; one was saccharic acid and the other probably oxalic acid.

The imposition of anaerobic conditions on farmyard manure produced a rapid build-up of the volatile acetic and propionic acids. The admission of air to a sample of manure in which volatile acids had been allowed to accumulate under anaerobic conditions caused their very rapid destruction, whereas anaerobic conditions had little influence on the non-volatile acid content of the manure, which was about 2 mequiv. per ton.

The small quantity of acids formed in decomposing farmyard manure, and low efficiency of release of soluble phosphate by these acids, indicated that the mechanism may be of little agronomic importance.

Fluidisation of Grain

Writing recently in *Zycie Warszawy*, on the work of the Institute for the Study of Grain established in Poland in 1956, Jan Lysak describes a grain-drying store designed by Professor Ciborowski which depends on driving heated air through the stored corn.

The interesting feature of Professor Ciborowski's project is that heated air is forced in at the bottom of the drying columns filled with grain at a speed balancing the weight of the grain. The grain is thus in a state of suspension and acquires a freedom of movement which permits intensive circulation of the heated air. It is claimed that this type of drying installation combines the advantages of speed of drying, high output and low heating costs.

The Ciborowski drying store has been tested in Poland on a semi-technical scale, but has not so far been tested on a technical scale.

Mechanisation of Indian Agriculture

R. C. HEATH

(Riley [Advertising] Ltd., London)

The author of this thought-provoking and constructive article has spent several years in India in a senior executive position and has made a particular study of the very difficult problem of agricultural mechanisation in that vast country.

THERE are approximately 45,000 tractors in India, but taking into consideration the size of the country and the vast area under cultivation such a small amount of mechanical equipment can obviously have very little impact upon the country's food production.

The Indian Government does not appear to have investigated the reason why other countries have found it necessary to resort to large-scale mechanisation, or the success which has resulted. It would also appear that its advisers do not fully appreciate the fundamental issue in respect of food production in relation to increased population. World history gives a pointer to the fact that man in more developed or progressive countries has found that he could not grow enough to feed himself using his bare hands or simple hand tools, so he turned to oxen, from oxen to mules and horses, and thence to the mechanical horse – the tractor.

Why is the farmer of India – the man who is responsible for the very existence and health of the nation, the man who is directly responsible for the country's progress and the development of secondary industries – left to himself to fight a losing battle against what could be either a formidable enemy or, if handled correctly and harnessed properly, the country's greatest friend – Nature?

Control of imports

Mechanisation of agriculture is not forging ahead in India as quickly as it should because recommendations made in 1950, in regard to the importation of tractors and implements, have not been put into proper effect – and as a result mechanical equipment has been left to lie and rust on the farms through lack of training, of spares and of service facilities.

With the idea of preventing this, it had been expressly laid down in the 1950 recommendations that in future all importers, dealers and distributors of agricultural machinery should be licensed after inspection by Government, and that permission to import agricultural machinery should not be given to distributors and dealers until the manufacturers whose machinery they represented and proposed to market guaranteed certain simple standards, such as adequate servicing facilities, workshop accommodation, skilled factory-trained technicians and training facilities, within the territory in which it was proposed to operate. If a manufacturer failed to carry out these standards, his licence for further importation was to be cancelled.

The Government has also failed to take the progressive farmer into its confidence and listen to his needs. Every progressive farmer will tell you that he has to have modern equipment in order to produce the right amount of food to maintain the country's growing population, but until Government

Subsoiling is not deep ploughing

The amount of power at the disposal of the peasant farmer. The animals are half-starved and the primitive plough is only capable of shallow cultivation of a small area

Where the soil has been baked by the sun and is extremely hard and difficult to plough, the use of a serrated disk harrow will ensure a good tilth

is prepared to offer loans to the cultivator to enable him to obtain modern equipment there is little chance of increasing his production and reducing his costs.

Unfortunately, both the central and State tractor organisations have been maintained at unnecessary expense and at a high standard of inefficiency, and this, it is appreciated, must inevitably lead to doubt in the minds of Central and State Governments as to the advisability and the advantages of the mechanical approach. On the other hand, whilst the manufacturer, the importer and the distributor must take their share of the blame for the failure, a very high percentage of the blame must be laid at the door of the people who have been in charge and also the people who have offered or given incorrect advice.

It requires little or no thought to appreciate that the central or the State tractor organisations should not at any time have had wheel tractors. They need only the crawler tractors used for extensive land reclamation and large-scale development work – work which cannot be undertaken by the cultivator. If after carrying out this large-scale land preparation the farmer is left to work his piece of land with his animal power alone, it will not be long before this primitive method of cultivation and the power at his disposal will be inadequate for him to continue, especially in kans*-infested areas, and so he is back where he started. It is only a matter of a year or so before he is overwhelmed by the weed, whereas, had he been able to purchase powered machinery of a light nature, he could have followed up the Government's original reclamation and kept the weed in check for all time.

Lack of power

Australia's rainfall on an average is half that of India, yet in Australia crop yields are double. Why is this? It is because the Australian farmer has had sufficient power at his command to work and cultivate his soil in keeping with his requirements and the varying seasonal conditions, and to plough at the right time and depth, and cultivate at the right time and at the correct speed. Whenever necessary, a 24-hour operation can be undertaken when the season demands it, which is quite beyond the scope of any animal.

Take, for instance, the operation of subsoiling. What farmer in India with only bullock power at his disposal could possibly undertake such a strenuous operation? Yet this is one of the surest ways of conserving moisture and practically guaranteeing a fair yield in most soils, even when drastically affected by drought. Unfortunately, the farmer in India is unable to carry out this operation; and his present depth of cultivation becomes more shallow yearly as his work power and that of his bullocks decline.

[*Note: Subsoiling is not deep ploughing; deep ploughing for the most part in this country is fatal.*—ED.]

A suggested plan

It is submitted that the Zamindari† Act, in its present form, is wrong and that a slower and more progressive process of elimination might have been considered. Had all Zamindari been advised that they could retain all the land that they had under cultivation at a defined standard of production and efficiency as an individual, or as a co-operative society, or a limited company, private or public, by, say, 1 January, 1962, the hard core of progressive, enlightened farmers would not only have gone thoroughly into the business of farming, but would have found the money to obtain advice and purchase all the necessary modern equipment, seed, fertiliser and stock for such an operation. At the same time, Government would have had to insist, in the case of those Zamindars who intended to become full-scale farmers, that for every 100 acres they intended to farm they would have to take one agricultural graduate, train him and feed, house and pay him at an agreed scale.

The land now available, which the Zamindari have been unable to handle, ought to be developed through circles or groups, but not as co-operative farms, *because co-operative farming never has worked and never will work anywhere in the world except as bulk buying and selling agencies on behalf of farmers.* Such State or national land units should be worked on a collective basis and the agricultural graduate, after his four years' practical training with a Zamindar, should be in a position to operate these lands and cease to be, what so often he now is, a farmer only in theory and become instead a real practical agriculturist. The agricultural graduate thus becomes the farm manager of the national collective farm in each of these areas, and on such collective farms Government can place the landless farmers. Small farmers of uneconomic holdings could join these collective

*kans: a prolific grass weed.

†Zamindari: Indian landowners who leased their lands to small cultivators.

Paddy is recognised as one of the most difficult operations to mechanise. The special extension wheels and puddling tool fitted make it possible to work the wet soil thoroughly and quickly and ensure good yields

units voluntarily, if they so desire; but those who do not wish to do so, and prefer to continue on their own, should be able to get assistance from a rural credit corporation, and the facilities offered by this corporation should be available also to the collective farm units, progressive farmers and even the Zamindari, where there is need.

All farms need certain basic equipment; that is to say, tractor, plough, trailer and belt pulley. Pools should be established at various strategic positions throughout the State, either by Government or by private contractors, from which farmers might hire on a day-to-day basis such auxiliary equipment as is vital for complete mechanisation – equipment such as threshing machines for rice and other cereals, shellers for maize, binders and mowers for harvesting, seed drills, seed cleaners and winnowers, and barn machinery, such as chaff cutters, hammer mills, grass driers, etc.

Need for credit

Development of agriculture and high productivity of primary produce in countries such as Australia, America and Canada were not achieved without financial investment on the part of the government of those countries. Land grants were made available to the farming community and substantial loans were given to farmers (by government, rural banks and finance houses) to enable them to develop their country's vital industry.

India needs to do the same, but unfortunately, legislation – under which farmers are protected in so far as collection of any debts incurred by them are concerned – preclude the granting of loans by any bank, insurance company or finance house. Therefore financial assistance to the farmers of India will have to be made available through a Government organisation, run on commercial lines, and working in close co-operation with the Revenue Department.

Hire-purchase arrangements

It is vitally necessary for hire purchase facilities to be made available to the farming community, and this could be done through what might be described as an 'All-India Rural Credit Corporation'. A sum not exceeding Rs.50 crores‡ should be sufficient to cover all expenditure and commitments necessary for the inception and operation of what should prove to be an adequate hire purchase scheme.

A recognised bank should be appointed as the all-India agent for the Corporation, and all financial arrangements in connection with the purchase of agricultural machinery and equipment should be transacted through that bank. In the first instance the facility or loan should be restricted to a maximum of, say, Rs.10,000/- per farmer, though farmers availing themselves of hire purchase facilities through this Rural Credit Corporation will not, in fact, handle any money at any time.

Farmers would be required to fill in a form declaring the extent of their holding, its assets, situation and crops grown, etc., and before any further action was taken this form would be sent to the Revenue Department to certify that the information it contained was correct. After scrutiny and acceptance the form would be returned to the farmer concerned with instructions that he should present it, together with a proforma invoice from a dealer licensed by the Government to trade in agricultural machinery, to the bank acting as the agent for the Rural Credit Corporation. This bank would thereupon execute an agreement as between the farmer and the Corporation.

Purchase of equipment

On completion of formalities connected with the execution of this hire purchase agreement the bank would authorise the farmer to purchase the equipment specified in that agreement and would at the same time hand him a voucher addressed to the dealer whose proforma invoice has been accepted and from whom the equipment was to be purchased. This voucher would constitute an order upon and authority for the dealer to supply the equipment. On completion of delivery in accordance with the instructions given by the bank the dealer would present the voucher – together with attendant documents, including the farmer's written acknowledgment of correct receipt – to the bank for payment.

When the entire transaction had been completed – that is to say, verification of the correctness of farmer's declarations, execution of the hire purchase agreement, collection of the initial instalment, delivery and payment of

‡50 crores = 5,000 lakhs = £750,000.

In view of the unpredictable climatic conditions, it is vital that each farming operation should be performed quickly at the right time. This machine for the inter-row cultivation of dry rice can cover many acres a day; a pair of bullocks might cover an acre a day

machinery – the bank would forward the hire purchase agreement and connected documents to the Rural Credit Corporation, whose responsibility it would be to collect all subsequent instalments with the co-operation of the Revenue Department.

The equipment would, of course, remain the property of the Rural Credit Corporation until full payment had been effected by the hire purchaser, and the Rural Credit Corporation would, of course, enter into a separate agreement with the dealer in regard to service visits during the hire purchase period.

The ultimate prospect

What would be achieved through such an approach giving positive encouragement to agriculture? The country's essential industry would be mechanised and so given the opportunity of producing more food at less cost and at a price within the reach of all. The profit of the rural population would be increased and the country would commence to expand its secondary industries as a direct result of the increased earning capacity of the farming community. Other industries, such as mining, would demand more steel and coal, as machinery and commodities roll off the production line for use on the farm. Transportation, servicing and repairs in connection with an expanding agriculture must increase employment all round.

Land Smoothing

In spite of the tremendous strides which farm mechanisation has taken in the last decade, little attention has been paid to preparing the land's surface in such a way as to enable agricultural machines to operate at maximum efficiency.

In the development of the motor car, road improvement has more or less kept pace. In agriculture complicated and elaborate machines, comparable perhaps to this year's models in the automobile world, are asked to do their best on field surfaces that have known but little improvement over a period of several hundred years, during which horses or other draught animals were used with simple farm implements.

Land smoothing and levelling is, of course, primarily done to obtain effective irrigation with less water and to control the water table with absolute accuracy. It is also used in rainfall areas to eliminate high and low spots of fields which interfere with the even moisture distribution and cause crops to be retarded or drown in the waterlogged, low-lying areas or become under-developed on higher, somewhat too dry areas of the field.

Farm mechanisation requires careful consideration of cost, for every time a wheel turns some hard cash, previously earned, leaves the farmer's pocket. Any preventable expense must therefore be eliminated. The practice of precision smoothing and levelling land can be considered one of the most efficient and productive ways to obtain these desirable results.

From a purely mechanical point of view, land smoothing will mean:

1. Less human fatigue in operating farm machinery.

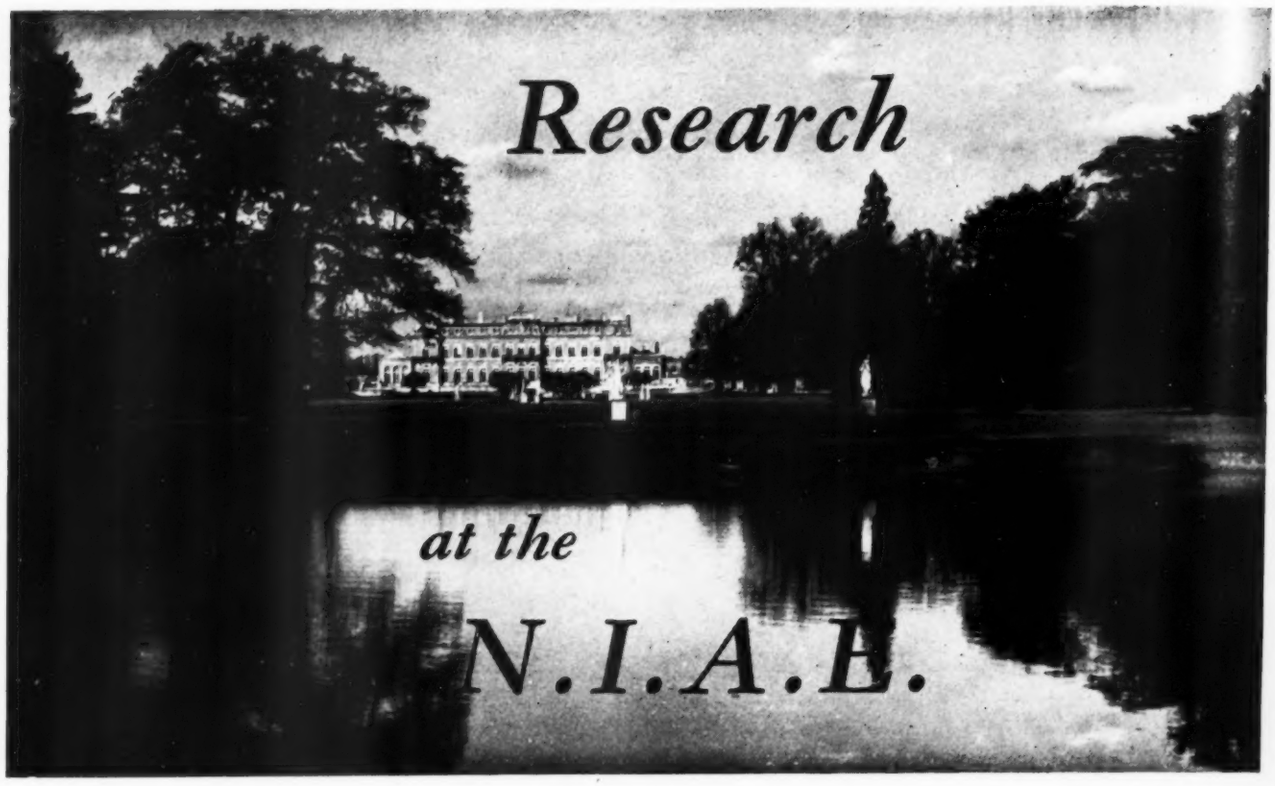
2. Substantially lower maintenance costs for repair and breakage occurrence, due to elimination of twisting, shaking, pounding and bumping, caused by irregular field surfaces.

3. Greater efficiency in the operation of harvesting equipment, resulting in greater output per man or machine-hour, since wider combines, wider hay cutters, wider rakes and planters can be used.

4. Seeds can be deposited uniformly at a predetermined depth on a smooth field.

5. All thinning equipment, as, for instance, on sugar-beets, can be operated far more efficiently and more reliably on smooth fields. At the same time, 6- and 8-row thinners can be used instead of 2- or 4-row, since with precision smoothing to a $\pm\frac{1}{2}$-in. variation from the true field grade can be guaranteed and maintained.

6. In harvesting a crop grown on precision smoothed fields, not only has all bumpiness of the field disappeared, but, due to moisture equalisation throughout the field, the stalk length will be more or less even throughout and the crop will be uniformly ripe at the same time. This makes it possible to cut that amount of straw only which enables the combine-harvester to separate at maximum efficiency. In an uneven field a very substantial amount of grain is lost because the separation chambers become overloaded with straw, since the farmer sets the cutter bar of his combine very low so as not to miss the grain growing in the many small, abrupt depressions.



Research at the N.I.A.E.

The Evolution and Testing of New Machinery and Farm Equipment

THERE has been a silent, uneventful and bloodless revolution in Britain during the past quarter of a century. Partly as a result of pressure of population and the shortage of servants, but mostly because of the very heavy incidence of taxation and death duties, the majority of the stately homes of Britain have changed hands and are today being used as schools, colleges and training centres; as hospitals, holiday homes and youth hostels; as hotels and country clubs; as showplaces, museums and national monuments; and as research and experimental centres – one such is today a centre for agricultural engineering research. It is, indeed, odd to find a copy of WORLD CROPS in the magnificent banqueting hall, which is now the Library of the National Institute of Agricultural Engineering.

The occasion was the second Open Day of the Institute, when all aspects of the work of the N.I.A.E. were demonstrated by means of practical demonstrations and static exhibits. The programme was arranged under departmental headings, and the exhibits were mostly to be found where the work was normally carried out.

Wrest Park – the ancestral home of the de Grey family for seven centuries – is today the headquarters of the National Institute of Agricultural Engineering. Its magnificent gardens, scheduled as a national monument, are 300 acres in extent and are well worth a visit by overseas visitors.

The research and development programme of the Institute is varied and wide in its applications; the objects of its researches are to provide exact data and the facts required by the design engineer, and to give the agricultural and horticultural specialist information on which to base new techniques. Research cannot today be separated from development because often the building of an experimental machine is the logical sequence to a research project; while each individual project has a definite objective, the actual research at the Institute may be carried out by as many as four departments. Already a number of machines, now in regular use on farms and market gardens, or in production, owe much to the work of the Institute.

Work of the departments

The objects of the *N.I.A.E. Testing Service* are to assist the development of agricultural and horticultural machines by providing performance data on prototype or new production models, and by making recommendations for their improvement, if necessary. The farmer and horticulturist gain from the availability of improved machines, and the published test reports provide him with an unbiased account of a machine's performance and other information on which to select a machine or implement to meet his special requirements. Other important aspects of the work of this department include investigations into the performance of fertiliser distributors and the wear of implements in the soil.

The *Field Investigation Department* is engaged in studying the diverse problems connected with the mechanisation of various crops, *i.e.* the problem of fitting the crop to the machine. At present, investigations cover the cultivation and harvesting of potatoes; the harvesting and storage

of cereal grains and of grass and clover seed; the artificial drying of bales of lucerne and grass; and the handling of bales. Work study techniques are being established for various farm operations, including the mechanisation of the silage crop.

The *Grain Department* carries out research and development work on machines for drying, cleaning, grading and handling grain, including the design of instruments and special equipment for checking performance. Special apparatus used for the grading of sugar-beet seed, based on differences in specific gravity, was on view, together with other laboratory-scale machines designed for research on seed cleaning.

The *Glasshouse Research Department* deals with the special problems relating to the growth of plants in artificial environments, not only under glass, but also in plastic-covered structures and mushroom sheds. There were also controlled-environment chambers for fundamental investigations. The work of the department covers investigations into the heating and ventilation of glasshouses, and the effect of different temperatures on growth and yield, and the water loss from plants under glass.

Perhaps the most interesting exhibit in the *Department of Horticultural Engineering* was the intermittent mist controller, for use in the propagation of cuttings, which is now in commercial production. There is an artificial leaf which serves as an automatic switch for the control of the supply of the liquid used to irrigate the plants. There was also an experimental low-volume fruit sprayer, which was being used for determining the air speeds necessary for spraying in a wind. A study is being made to decide how to prevent and also how to make use of spray drift.

The work of the *Mechanical Engineering Department* covers the testing, research and development of machines and power units. The department includes the drawing office and the main workshop, which serves all the other departments of the Institute. Tractor testing today is routine (see WORLD CROPS, 1957, **9**, 422); there is now a dust chamber, a hot chamber and a cold chamber and also a special unit for testing engine performance at high altitudes. Work with the hydraulically-propelled N.I.A.E. tractor (see WORLD CROPS, 1958, **10**, 137) is now concerned with its practical application in agriculture; further work is being done on the relation between soil characteristics and tractor performance.

The *Soil Department*, as its name implies, is concerned with research and development of machines which either work in the soil, or harvest crops from the soil. The immediate aims of the work are to explain what happens to soils during cultivation, and to find out the origin and the nature of the loads that different soils put on cultivation implements. Development work is undertaken only when no satisfactory machine exists. The results of this pioneer work are made available to manufacturers at any stage.

Finally, there is the *Instrumentation Department*, on which so much of the work of the Institute is based, as almost all the research work and testing depends on facts and figures obtained by the use of physical measurements, chemical analysis and metering and recording devices including

Cause . . . *A system of land preparation designed to obviate the need for accurate levelling and contouring is undergoing field trial in East Africa*

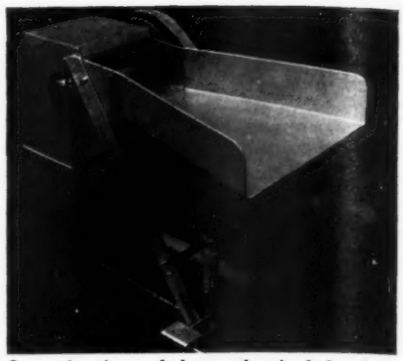
. . . and Effect *This method of holding water increases the infiltration and so conserves the uneven and erratic rainfall. It is being tested for groundnuts, cotton and maize*

A production prototype of a groundnut harvester being tested in East Africa. This machine will lift the plants and strip the roots of their nuts in one continuous operation

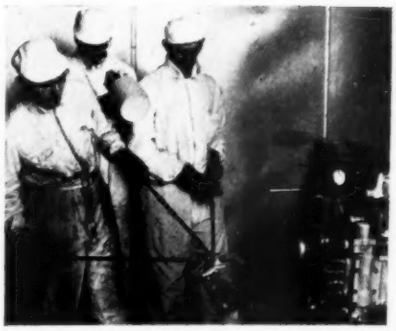
Left:
An experimental tractor for row-crop cultivation. The machine is packed with recording instruments designed to record deviations from a desired course and the force and movement to be applied at the steering wheel and the optimum transmission ratio

tachometers, pressure gauges, thermo couples, electrical and electronic instruments. Cine and still photography units assist in the testing and development work and in the production of cine films for public showing.

It is impossible in this short article to give a full account of the Field Day or to do proper justice to the work of the National Institute of Agricultural Engineering. The Annual Report for 1956–57 is remarkable for its brevity and business presentation of reports on some 202 investigations, which is available to members of the British Society for Research in Agricultural Engineering.



Investigations of the mechanical threshing of rice, using a machine suitable for the peasant farmer, have been carried out in the Federation of Malaya



Right:
The use of a radioactive piston ring to determine the movement of oil in the lubrication system is a remarkable new technique. The Geiger counter is used to follow the path of the tracer particles

Uses of Vegetable Fibres

Banana Fibre for Bags

Experiments with locally - grown banana fibre in the manufacture of grain bags are being carried out in Rhodesia; bags have been made containing up to 30% of banana fibre, and 50% of sisal and banana fibre combined. The bags appeared under physical and laboratory test to be as strong as normal bags made from 100% jute, says a report. They are, however, slightly coarser in appearance, but it is believed that when a technique for ' batching ' and carding the fibres has been perfected the resultant product will be indistinguishable from jute.

The factory is buying dried 'ribbons' of banana stalk from growers in the Umtali district and across the Portuguese border. Although the yield of fibre per acre cannot yet be stated with accuracy, it is thought that the yield will be between 1 and 1½ tons of dried ' ribbons ' to the acre. The factory is paying £25 per ton and is prepared to absorb all locally-grown fibre as soon as it is satisfied that a clean fibre can be obtained. Only the banana stalk is used, as it has been found difficult to obtain a clean fibre from the leaves.

Shortage of Hemp

The supply of Philippine hemp reaching the U.S.A. is not enough to meet demand, according to a statement made by Frank Metcalf, of the Colombia Rope Co., of New York, to the late President Magsaysay of the Republic of the Philippines.

Manila hemp is a large herbaceous perennial or small tree of the banana family, which is indigenous to the Philippines, where it is extensively cultivated for its fibre. To obtain this, the soft succulent stems are cut down just before the plant begins to flower. After removal of the broad leaves, each stem is divided into strips about 3 in. wide. Each strip is then drawn by hand through a clamping knife, which removes the watery pulp from the fibres. The hemp fibre is then bleached and dried in the sun and made up into bales of 275 lb. for export.

The plant requires a hot, moist climate, deep heavy soil and a good rainfall and is best suited to elevations below 1,000 ft. Its cultural requirements are similar to those of the banana, which it closely resembles. The hemp plantations are confined chiefly to flat volcanic land in the Philippines and the island of Davao is the main centre of production.

Rayon from Sisal and Sugar-cane Waste

New machinery and equipment for the production of rayon cloths, costing $2½ million (£870,000), have been installed in the province of Azua, Dominican Republic. They are expected to give added momentum to the development of the sisal industry there. The rayon cloths will be manufactured from the waste products of sisal and sugar-cane and from certain native woods.

The growing of sisal in the Dominican Republic began only in 1952. Since then large plantations have been developed, providing both for home consumption and considerable quantities for export. Sacks made from Dominican sisal are said to be 16 times as strong as imported jute sacks.

Breeding for Mechanisation

Fitting the Crop to the Machine

JACK B. KEMMERER

(*Los Angeles, California, U.S.A.*)

Heredity ultimately determines the maximum potential yield of which a plant is capable; to increase that potential, and at the same time to make it suitable for mechanical cultivation and harvesting, it is necessary to change the nature of the plant by breeding to special requirements. The problem is to provide the nation, and the world, with the quantity, quality and variety of food required by an ever-increasing world population and an ever-increasing standard of living.

THE plant breeder has played an extremely important part in the mechanisation of agriculture in the U.S.A. In creating new, green growing tools to fit the intricate monsters produced by the farm-machinery companies, he has made the work of the late Luther Burbank* look tame by comparison.

He has produced a wheat so heavy in yield that granaries are overflowing, and farmers could today produce enough wheat to feed the entire world. He has created cotton with fibres of tremendous strength. The new sweet garden corn is more tasty and yet is immune to most diseases and insects refuse to eat it. The maize now grown in the Cornbelt stands up against high winds, resists drought and corn borers and performs miracles in outyielding all previous varieties.

One hundred years ago each of the seven million American farm workers produced enough food and other agricultural products for himself and three other persons. At the time of the First World War it required 15% of those gainfully employed to grow and harvest 90% of the foodstuffs that moved from the farm to the consumer. Today only 9% of our workers do the same job, and each of the eight and one-half million farm workers now produces enough food for himself and 18 other workers; agriculture has thus made a 50% cut in labour needs and at the same time produces 54% more food.

Mechanisation and yields

Two factors have assisted in making such increases possible – higher yields and farm machinery. Today there are about 12 million fewer work animals on farms in the U.S.A. than 50 years ago, releasing more than 50 million acres of land from the job of producing horse feed. Tractors and tractor-drawn machines, that have replaced the horses, have so increased the efficiency of farm labour as to create yet another miracle. The value of all the machinery on U.S. farms, including motor vehicles, has today reached the astounding sum of $17.7 billion, according to a recent survey by the Federal Reserve Board. This is $10 billion more than the net investment in the entire U.S. steel industry.

Most of this mechanisation, however, could not have occurred without the assistance of the plant breeder. For without higher-yielding and otherwise improved varieties of grains, fruits, forage crops and vegetables only a fraction of the increase could have been realised. Miles and miles of drought-resisting grain sorghum, for instance, came to the hard-hit South-West only after plant breeders had perfected a low-growing type, with erect stalks, that the combine could easily take into its maw.

To effect cross-pollination the flower of the bean must be opened, the male element removed and the male element from another strain dusted into the flower

The vast change and improvement in our national diet over the last few years has been due almost entirely to the little-known plant breeder working quietly in experimental fields, controlled greenhouses and laboratories located in the major agricultural districts.

The term 'in season' has almost ceased to have any meaning to the housewife because he has created improved types of vegetables especially for canning, freezing and shipping. In this amazing plant modernisation programme nearly every vegetable has come under the close scrutiny of the plant breeders.

There are many facets to a plant breeder's work. The most generally known is the improvement of flavour and appearance, but of equal importance to the commercial grower is building up resistance to disease and breeding for greater yield.

Canning, freezing and shipping costs are more or less a fixed charge. There is, however, one item of which labour costs can be drastically reduced – the actual harvesting and handling of crops.

Cultivating fields, planting, irrigation, applying insecticides and fertilisers have been handled by machinery for years. The actual picking of vegetables is still, in many cases, a hand job, with resulting high costs. Farm machinery companies working in this field have produced numerous machines for harvesting such crops, but there is more to machine-harvesting than having a machine capable of doing the job. The vegetable itself must be tailor-made for machine harvesting and here plant breeders again enter the picture.

* A famous Californian plant breeder.

Specifications for a bean

A good example is the recent request from green-bean processors for a machine for harvesting pole beans; although some varieties of pole beans do lend themselves to machine picking, the ideal has so far not been produced.

The following are the complete specifications for a bean suitable for machine harvesting and perfect in all other respects:

1. The bean must be suitable for all bean-growing areas.
2. It must have ' Blue Lake ' flavour (acme of green bean flavour).
3. It must be resistant to common bean virus – mosaic disease.
4. It must be stringless.
5. The structure of the plant must be such that the bean pods are carried uniformly in the same place on each plant. The raceme, or inflorescence, must be of a standard length on every plant, so that the machine can pick all the mature beans.
6. As the machine will go through the field three times, the plant must have a strong root system and the bean must come off the plant easily without damage.
7. The crop must be so concentrated that a large number of beans mature at the same time.
8. The beans must be of a uniform size, as near the same length and diameter as possible – 5 to 6 in. is preferred, as this size fits snipping machines most efficiently.
9. They must all be of uniform dark green colour.
10. There must be a high yield per plant.

To breed beans resistant to virus a healthy plant is repeatedly inoculated with the virus from a heavily diseased plant

To prepare a healthy plant to receive the virus the epidermis of the leaf is broken with finely-ground carborundum

The ground inoculum is applied lightly to the bruised leaf with the pestle from the mortar in which the diseased leaves were ground

Method of evolution

Changing a vegetable's habits in all these respects cannot be accomplished overnight; the process usually requires 10 or more plant generations, using several varieties of plants, each having one or more of the required genetical characteristics. Such projects are now normally carried out in greenhouses. By using controlled greenhouse facilities, plant breeders can speed up the process from one plant generation per year to two, thus saving five years in 10 plant generations.

The first and succeeding generations are cross-pollinated by hand. Crossing and recrossing of the generations continues, often using several thousand individual plants in the process. Each generation is examined closely, only those strains being kept for further planting that have more and more of the desired characteristics.

This process of elimination gradually reduces the field to a small number of plant strains meeting all specifications. Seed from these plants is then planted in the field for tests under normal growing conditions and the mature beans receive a field test with the new picking machine. Records are also obtained for both yield and uniformity of maturity and from all these results the breeder selects the preferred strain and plants it for seed production.

Two approaches

In plant breeding there are two different methods of approach, depending on the type of plant being bred. In the case of the pole bean, the method used was hybridisation with subsequent selection from the thousands of plants grown. This method is used when the plant would seldom be cross-pollinated in nature because of the closed type of flower structure.

The other method, the production of a first generation or F_1 hybrid is used on those plants that cross-pollinate easily in nature. Seed companies prefer the F_1 hybrid, as the seed for such a plant must come every year from the same two parent plants which were originally crossed to get the F_1 hybrid and, of course, the company producing this particular hybrid is the only one with the parent stock and so the only one able to produce seed each year.

A typical problem

An example of a change in the nature of a crop may be quoted. One soup company's food experts found the pale yellow cubes among deep orange cubes in a vegetable soup lacked eye appeal and odd-shaped carrots left too much waste in passing through the dicing machines. Eight years and many thousands of carrots later the breeders had isolated 10 carrots with a solid orange core, and all were of the same shape and size. Today offsprings from these same 10 carrots annually produce seed to plant 100,000 acres of carrots.

The changing of a vegetable's habits is generally a long and tedious job and the work of improving agricultural crops, increasing yields, developing greater resistance to disease, insects and drought appears to be endless.

Feeding the population in the U.S.A. was in the past a comparatively easy matter; they merely increased the acreage – first by spreading to the west and more recently by draining swamps and irrigating deserts. Now, stepping up the output of the areas already under cultivation is the only way left for America to provide for the future.

Fertilising Forest Trees

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The following is a shortened account of important work being done in the Netherlands on the application of nitrogen, phosphorus, potash and lime to forest trees

IN the Netherlands approximately 250,000 ha. are under forest. This is roughly 7% of the total land area and less than 15% of the total area under cultivation. Roughly 70% of the forest consists of conifers and are mostly production plantations; the remaining 30% are under deciduous trees and are mostly recreational areas.

The most common conifers grown for the production of timber, poles and props are: Scotch pine, *Pinus sylvestris*, Douglas fir, *Pseudotsuga Douglasii*, Japanese larch, *Larix leptolepis*, Norway spruce, *Picea exelsa*, and Sitka spruce, *Picea sitchensis*. The principal deciduous tree grown for timber is poplar, *Populus canadensis*.

The main soil types in the conifer plantations are podzolised sands of glacial origin. The *p*H is usually lower than 4.5. The nitrogen supply of reforestations is moderate and that of heathland afforestations inadequate.

Phosphate contents of humus podzols are very low, but that of humus-iron podzols are reasonable. On the average 'P total figures', expressed in mg. P_2O_5 per 100 g. oven-dry soil, of humus podzols and of humus-iron podzols are respectively 10 to 25 and 20 to 60. Potash deficiencies only show up in conifers, which require an extremely high supply of this element. Deciduous trees are grown on a variety of soils, but generally the more fertile alluvial soils are reserved for poplar.

Little evidence is available regarding the response of forest trees to fertilisers and the results of the present field experiments are not expected to be available for at least another 15 years.

A lime blower in action in a forest in Holland during the winter

The Japanese larch

A number of experiments so far completed have been on Japanese larch. Van Goor[1], in an early publication, emphasises the antagonism of nitrogen and phosphates. This conclusion was reached from a number of pot trials on seedlings which received nutrient solutions of different composition. It was shown that nitrogen decreases the uptake of phosphorus and *vice versa*. Optimum growth was obtained at a narrow range of N/P_2O_5 ratios of the needles, lying between 4 and 5.

The negative effect of nitrogen on phosphorus uptake appears to be much more pronounced than the antagonistic effect of phosphorus on nitrogen uptake. Thus additional phosphates affect the dry weight production adversely and depress the N/P_2O_5 ratios of needles to values below the optimum only if the nitrogen supply is extremely low. On the other hand, even when the supply of phosphates is high and well above the level required for optimum production, additional supplies of nitrogen over the optimum will result in a decrease of growth, which is also reflected by N/P_2O_5 ratios of the needles higher than 4 to 5.

In a later paper Van Goor[2] discusses the disturbing effects of liming on the growth of Japanese larch. He deals with the results of field experiments on four sites with soils low in phosphates. High limestone or lime dressings appear to depress the growth of larch. This is in accordance with the results of pot trials on the antagonistic effects of N and P found previously by Van Goor,[1] as liming favours the nitrogen mineralisation of soil organic matter and the soil phosphate supplies are low. Applications of limestone up to 1,000 kg. per ha. are advisable on afforested heathland. Higher dressings result in growth depressions. Applications of phosphatic fertilisers on these

Japanese larches at five years.
Left: *No fertilisers.* Right: 1,000 *kg. limestone and* 400 *kg. basic slag per ha.*

soils of low phosphate status are recommended.

The Norway spruce

Preliminary results of three fertiliser trials on Norway spruce have been published by Van Goor.[3] The experiments were carried out on sandy loams. The original heathland had been afforested with Norway spruce 15 years ago. Growth had been poor, as indicated by the average tree height of 1.50 m., and in between the trees, heather had re-established itself. Fertilisers were applied in the early spring of 1955. Towards the end of the 1955 growing season, needle samples were taken and analysed for mineral constituents.

Before the fertilisers had been applied, the needles showed a yellowish-green colour. They were small and they stood closely together on the twigs. The oldest needles were often covered with a black haze of algae. Colour changes took place rapidly in the needles of trees growing on plots which received fertilisers that contained nutrients in a readily available form. Calcium cyanamide and compost showed no reaction. On plots which only received sulphate of ammonia or nitrochalk the needles turned dark green. In 1956, brown and violet discolorations appeared in the older needles, which subsequently dropped. Applications of nitrogen and phosphate together changed the colour of needles to light green. Besides, newly developed needles were significantly bigger and were spaced wider on the twigs. The size and stand of old needles did not change.

Applications of fertilisers containing phosphates as mono- or dicalciumphosphate made the average concentration of P increase from 0.10 to 0.17%. This latter figure is near the concentration required for optimal growth. Compost acts much slower than the quickly-working phosphatic fertilisers.

Nitrogen deficiency was indicated by visual symptoms and by average N contents in the needles of approximately 1%. Nitrogen treatments resulted in a substantial rise in the N-concentration up to almost 2%. Calcium cyanamide and compost had a much less pronounced effect than materials containing nitrogen as ammonia or nitrate.

Particularly noticeable was that in one experiment tillage operations had eliminated the competition of heather and as such had an effect identical to the application of a nitrogenous fertiliser. The N content of needles sampled on plots which received both nitrogenous and phosphatic fertilisers was lower than the N concentrations of needles collected from plots which were only dressed with nitrogenous fertilisers.

Growth responses were only small in 1955, but had increased substantially towards the end of the second season, following the fertiliser applications. Measurements on the elongation of the central shoot clearly showed the need of nitrogen and phosphate and, where the land had been tilled, possibly also of potash. Compost supplied the required elements undesirably slowly. Raw phosphates and artificials, containing phosphates in either water- or citric-soluble form, appeared to be equally effective. Liming was of no consequence. The optimal rate of a nitrogen application in the presence of a dressing of Algerian phosphate of 1 ton per ha. was in the order of 40 to 80 kg. per ha.

Unlike Japanese larch, the Norway spruce shows a marked response to nitrogen on afforested heathland. Excessively high dressings of compost might cover the nitrogen need, but it would be costly and impracticable to apply large quantities and it is necessary to resort to artificials, though calcium cyanamide is not very effective. On the acid heathland Norway spruce responds equally well to basic slag and to mono-, di- and tricalciumphosphate.

Scotch pine and Corsican pine

'Yellow tip' is a commonly occurring disease of Scotch and Corsican pine. The cause has been investigated by Van Goor.[4] Symptoms consist of a growth decrease and of a yellow discoloration of the needle tips. The base of the needle stays green and the transition to the yellow tip is abrupt. In very severe cases the needle shows necrosis at its tip. The discoloration presents a certain periodicity by being more pronounced during autumn and winter than in summer, when in most cases the tip turns green again. The disease occurs more frequently in young than in old trees and is confined mainly to podzolised glacial sands with a natural vegetation of heather and to inland dunes of glacial sand.

A study of the literature reveals that 'yellow tip' has been identified in some cases with potash deficiency and in others with deficiency of magnesium. Only if caused by an insufficient supply of potash are the discolorations accompanied by a decrease of growth.

'Yellow tip' disease can also be induced by excessive manuring with calcium-containing fertilisers, but comparative results of chemical analysis of needles, sampled in the winter from diseased and from healthy trees, indicate that, in the Netherlands, potash deficiency is the main cause of the disease. The minimum concentration of K in the needles of Scotch pine below which visual symptoms of potash deficiency manifest themselves is of the order of 0.35%. Above this concentration, the only symptom of the disease is a reduced rate of growth.

The K content of the needles is not an absolutely certain indication of potash deficiency. Corsican pine growing on inland dunes, rich in potash but poorly supplied with other plant nutrients and showing 'yellow tip',

had an average K content in the needles of 0.55%. Samples of needles taken from healthy plants growing on a nearby site showed an average concentration of 0.72% K. There were no differences in the contents of N, P, Ca, Mg and Mn between healthy plants and those showing ' yellow tip '. In all cases Mg contents were low.

These analytical results, taken in conjunction with the fertility status of the soil, suggests a luxury consumption of potash due to an unbalanced supply of nutrients. A correction of the excessively high potash supply could be expected from the application of artificials other than potash. Subsequent experimental evidence has shown this to be correct.

Phosphorus

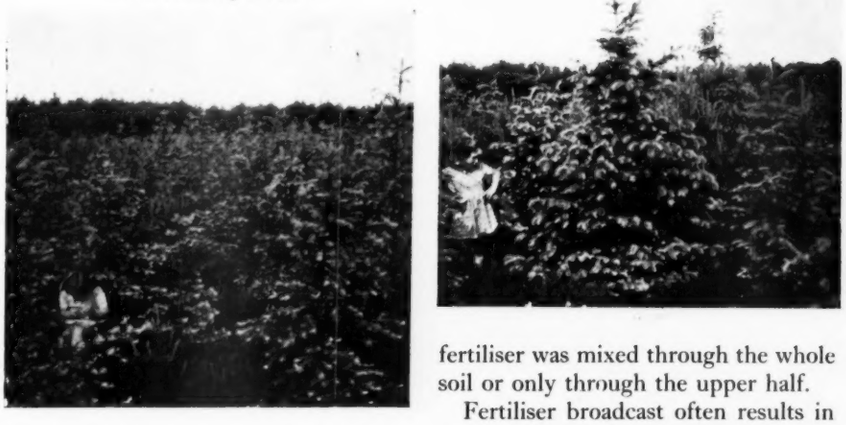
' Box trials ' have been conducted by Van Der Meiden[7] to study the influence of rates and methods of application of basic slag on the development of roots and shoots of poplar cuttings. Applications of basic slag had a pronounced effect on the dry matter production of both roots and shoots. Of the different ways of application, mixing the artificial through the whole of the soil mass was superior for both root and shoot development than any other method. Following this technique different rates had no effect on the dry weight production of roots. Equally good results were obtained from dressings of 5 and of 25 g. basic slag per box. The rate of 5 g. per box represents an application of 250 g. per planting hole of the usual dimensions of 60 × 60 × 60 cm. On the other hand, the production of shoots increased in an almost linear progression over the four rates nil to 25 g. per box.

Mixing the fertiliser through one of the upright halves of the box clearly showed the stimulating effect of a dressing of basic slag on root development. The unfertilised half was almost devoid of roots. Total dry matter production of roots at the lowest application rates employed was substantially less than when the artificial was mixed through the whole of the soil. At equal low rates, the dry matter production of shoots was only slightly less.

Higher rates of application showed a more pronounced depression of the production of both shoots and roots. Mixing the fertiliser through the lower half of the soil resulted in lower yields of both roots and shoots. Practically all roots could be found in the lower section of the box and almost none occurred in the upper part, which remained unfertilised. The root distribution pattern when the upper half was fertilised was the same as when the artificial was mixed through the total soil mass. Nevertheless, the dry matter production of roots was approximately 25% less and also the weights of shoots fell behind, though not to that extent.

Spot placement of basic slag was highly inferior to any other method of application. Boxes treated this way showed hardly any response, either in the roots or in the shoots. Application of basic slag in horizontal planes stimulated root and shoot production, but not to the same extent as when the fertiliser was mixed through the whole soil or only through the upper half.

Douglas fir at eight years, growing on afforested heathland. Left: *No fertilisers.* Right: *1,000 kg. basic slag and 400 kg. nitrochalk per ha.*



Fertiliser broadcast often results in a luxurious development of grasses which makes weeding necessary. This drawback might be overcome by applications of the artificials to the planting hole. The practice is highly recommended for poplar. Clean weeding raises the content of available soil nitrogen. A similar effect may be obtained from the inter-cropping with weed-suppressing crops like alder or Jerusalem artichoke.

Lime

The liming factor has been defined as the number of kg. per ha. of acid-neutralising components which are required to raise the *p*H of the topsoil down to a depth of 10 cm. by 0.1 unit. Acid-neutralising components (a.n.c.) of a liming material are all those ingredients with which hydrochloric acid may be neutralised. The contents are expressed in equivalent percentages of calcium oxide (CaO). As the clay content of forest soils is often insignificantly low the percentage of soil organic matter usually offers a sufficiently accurate basis for the estimation of the quantity of lime required to raise the *p*H to a certain predetermined value. The liming factor is a function of the saturations of the adsorption complex with bases and of the volume weight of a soil. The adsorption complex is composed of organic matter and clay.

Very often the forest floor consists of a layer of raw humus. This layer neutralises part of the lime dressing and consequently rates of application will need to be higher. Provisionally the following extra dressings are recommended:

Per cm. raw humus of conifers: 100 kg. a.n.c. per ha.

Table 1
Relative requirements of pH and main plant nutrients in silviculture

Tree species	*pH*	*N*	*P*	*K*
Scotch pine	Low	Low	Low	Moderate
Douglas fir	Moderate	High	High	Very high
Japanese larch ..	Low	Low	High	Low
Norway spruce ..	Low	High	High	Moderate
Sitka spruce	Low	High	High	Moderate
Poplar	Moderate to high	High	High	?
Other deciduous trees	Moderate to high	High	High	?

Per cm. raw humus of heather and deciduous trees: 150 kg. a.n.c. per ha.

Liming materials commonly used are summarised in Table 2.

Of these materials, chalk and dolomite can be applied with a dusting machine, but ordinary limestone is too coarse.

On the usually acid forest soils superphosphate, ground rock phosphates, basic slag and di-calcium phosphate give equally good results. The fertiliser may be machine dusted. These materials do not need to be worked in, as they penetrate sufficiently deep into the soil with rain. Superphosphate is specifically recommended on neutral or on slightly alkaline soils. Phosphate ammonsaltpetre, a mixture of ammonium nitrate and di-calcium phosphate, analysing 20% N and 20% P_2O_5, may be applied on soils which require both nitrogen and phosphate.

Table 2
The most common liming materials used in silviculture

Description	*Main active constituent*	% *a.n.c.*	% *MgO*	*Fineness* < 0.25 *mm.*
Limestone	$CaCO_3$	>40	<3	>60
Chalk	$CaCO_3$	>50	<3	>80
Dolomitic limestone	$CaCO_3$	>35 to 55	<3 to 4	>80 to 100

Nitrogen

The nitrogen requirements cannot properly be determined from soil analytical data, but analyses of needles may offer a useful index. In practice the most valuable index is a deficiency symptom. These are impaired growth and light green to yellow needles. They occur most commonly in heathland afforestations, particularly in plantations of Norway spruce, Sitka spruce, Douglas fir and other such timbers which require an ample supply of nitrogen. Only for young plantations of Norway spruce showing nitrogen deficiency symptoms has a fertiliser scheme been worked out. These trees require a dressing of approximately 60 kg. N per ha., equivalent to 300 kg. nitrochalk. Cultivations are only needed if there is an excessively developed grass cover. If the undergrowth consists of heather, such a practice can be omitted and the fertiliser may be broadcast directly. If soil analyses indicate the possibility of phosphorus deficiency, phosphate ammonsalpetre may be used or otherwise an additional dressing of phosphatic materials should be given, as nitrogen applications alone will show little or no effect. The nitrogen dressings should be applied during the spring, preferably when raining. Sulphate of ammonia and calcium cyanamide are unsuitable fertilisers in forestry practice. On poplars a dressing of 100 g. of nitrochalk per tree applied in May and June and repeated up to the fourth year after planting guarantees an ample supply of nitrogen. On phosphate-deficient soils phosphate ammonsalpetre may be given instead and about 1 kg. of basic slag should be mixed through the soil mass of the planting hole.

Potassium

No interpretation of soil analytical data is as yet available for the estimation of potash requirements. Visual deficiency symptoms are used for guidance, such as ' yellow tip ' in pines. Applications of 100 kg. potassium sulphate, together with 25 kg. magnesium sulphate per ha. or of 100 kg. potassium magnesium sulphate per ha. or of muriate of potash at a rate of 100 kg. per ha., are recommended. In extreme cases an additional dressing of 250 to 500 kg. basic slag per ha. should be applied.

Acknowledgments

The author gladly expresses his thanks to the Director of the Forest Research Station T.N.O., Dr. H. van Vloten, and to his research officers, Messrs. C. P. Van Goor and H. A. van der Meiden, for the co-operation received in the compilation of data.

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7. Van der Meiden, H. A. (1957): ' Reactie van populieren stek op fosfaat (Een orienterende proef'). Bosbouwproefstation T.N.O. Korte mededeling nr. 31.

Photos: C. P. van Goor.

Technical News

Articles in the October issue of some of the other journals of the Leonard Hill Technical Group include the following:

Building Materials Export. – ' Termite Damage to Buildings – a Problem of Tropical and Sub-tropical Countries ' by W. Victor Harris.

Manufacturing Chemist. – ' Review of Air Conditioning Equipment '.

Chemical & Process Engineering. – ' Fluid Handling '; ' Review of Fuel Efficiency Exhibition '.

Dairy Engineering. – ' Notes on Rinsing—2' by George B. Beattie; 'Italy's Most Modern Dairy '; ' Dairy Waste Disposal by Balanced Biochemical Bio-Oxidation – 2 ' by Nandor Porges.

Automation Progress. – 'Automatic Weighing ' by L. Saunders.

Paint Manufacture. – 'Aluminium: Versatile Pigment '.

Corrosion Technology. – ' Metal Spraying in Relation to the Corrosion Process ' by J. R. Franklin; ' New Developments in " In-Situ " Cleaning ' by P. B. Wharton.

Atomics. – ' Industry's Powerful Tool – Radioactive Isotopes'; 'Where do we stand in Regard to Radiation?'

Food Manufacture. – ' Corrosion in the Food Industry ' by J. W. Selby.

Scientists in Session

A party of 36 scientists and technicians from many parts of the world recently attended a 10-day course at the Chesterford Park Research Station.

The purpose of the course, which was organised by Fisons Pest Control Ltd., was to bring them up to date in the principles and methods of crop protection in tropical and sub-tropical countries. Lectures were given on the latest agricultural chemicals available for the control of weeds, insect pests and disease and the techniques of application.

A Forest Machinery Exhibition

Comprehensive Display of New Methods, Machinery and Equipment at an Aerodrome in England

THE Forestry Commission of Great Britain were responsible for arranging a most useful exhibition of forestry machinery and equipment at Blackbushe Aerodrome in Surrey, with practical demonstrations in the pinewoods and heathland adjoining, of scrub cutting, cultivation, earth moving, drain cutting, forest spraying by helicopter, timber extraction, sawing and bark peeling.

Opening the proceedings, the Chairman of the Forestry Commissioners, the Earl of Radnor, K.C.V.O., said:

'Many woodland owners in this country are noted for the fine forestry they practise and much credit is due to them for persevering often in the face of difficulties. On the other hand, owing to compulsory war-time fellings and present-day costs, a lot of owners have been unable to replant their felled woodlands. The Forestry Commission have long urged woodland owners to step up the rate of replanting areas which are unproductive and have become a serious threat to the surrounding land owing to their harbourage of vermin of all sorts.

'I am very pleased to say that many have responded to the appeal. There is evidence on all sides of a revival in interest in forestry, and one can see many examples where devastated woodlands are now being taken in hand. The weeds and scrub, which have taken the place of the trees which were felled, are disappearing and young trees are being planted which, in days not so very far ahead, should help the finances of their owners and the economic wealth of the country.

'In order to encourage this, the Forestry Commission have introduced a number of schemes through which financial and technical help is available to private woodland owners. For example, the Dedication of Woodlands Scheme, which requires an owner to use his land permanently for timber production, includes more than 1,100 estates, between them covering nearly half a million acres, and dedication schemes are in preparation in respect of a further 340 estates covering 118,000 acres. Plans are being completed in respect of a further 100 estates of, between them, 29,000 acres. Help for planting in small woods has also been widely accepted, while other schemes which contribute towards the cost of certain forestry operations, such as scrub clearance before planting, and thinning for timber production, have also found much favour.

'Actual replanting and new planting by private owners in recent years has risen as follows: 1954, 19,100 acres; 1955, 22,100 acres; 1956, 27,100 acres; 1957, 31,600 acres.

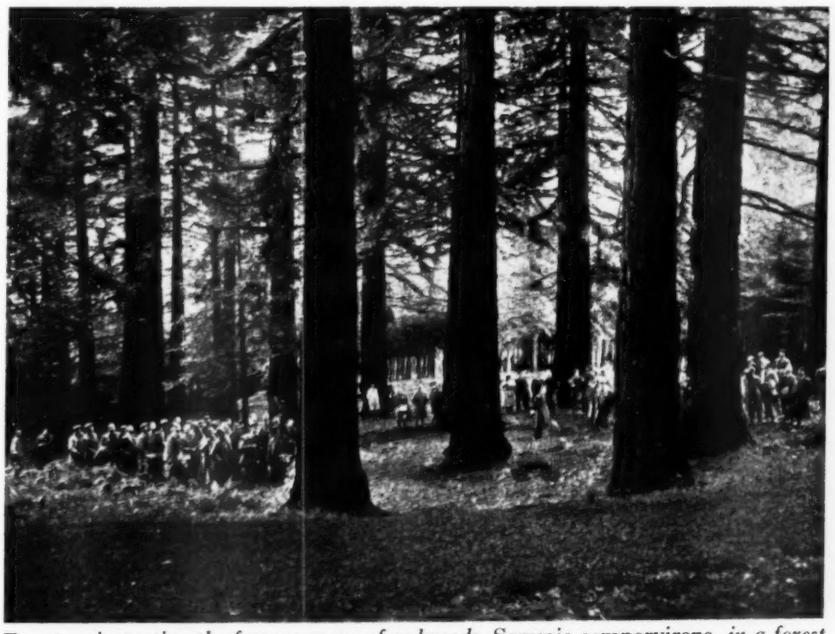
'Clearly the private woodland owner deserves encouragement to extend his estate forestry and he may rightly expect some guidance as to what are the right tools for the job. This is the primary purpose of this Exhibition, for on the various stands will be found a great variety of machines which will serve large-scale forestry and the less ambitious operations that are undertaken on small estates and by farmers. There are, in fact, many more machines available for forestry work than is generally supposed and much of the machinery is relatively inexpensive.

'The Commission are grateful to the many enterprising firms of machinery manufacturers who are doing valuable pioneering work in designing or adapting devices with the needs of the forester in mind. The cost of forest labour has inevitably tended to rise over the past few years and machinery such as can be seen at this exhibition provides the best answer to the woodland owner's problems of offsetting increased costs.'

We would add that the potential market for forestry machinery and equipment in countries overseas, not only in actual forestry operations, but also in felling senile rubber and coconut plantations prior to replanting and for clearing jungle and scrub for colonisation schemes, is enormous.

An account is given on page 381 of some of the exhibits and the exhibitors and firms which participated in the practical demonstrations included:

Saville (Tractors) Ltd., Mayfield Engineering (Croydon) Ltd., County Commercial Car (Sales) Ltd., John Wilder Ltd., Materials Handling Equipment (G.B.) Ltd., Stenners of Tiverton Ltd., Sabre Cutters (Southern) Ltd., John Allen & Sons (Oxford) Ltd., Tractor Shafts Co.



Foresters inspecting the famous grove of redwoods, Sequoia sempervirens, *in a forest near Welshpool in Wales* Photos: Forestry Commission

Preparing pit props for the North Wales collieries from timber grown in Wales

Ltd., Clifford Cultivator Ltd., Rotary Hoes Ltd., Edward Elwell Ltd., J. R. Gordon & Co. Ltd., H. Cameron Gardner Ltd., R. H. Neal & Co. Ltd., Packman Machinery Ltd., The Rover Co. Ltd., John Smith & Co. (London) Ltd., Ransomes Sims & Jefferies Ltd., Whitlock Bros. Ltd., Bristol Tractors Ltd., British Trailer Co. Ltd., C. D. Monninger Ltd., Sandvik Swedish Steels Ltd., W. Hargreaves & Co. Ltd., Walter A. Wood Co. Ltd., Hayters (Sales) Ltd., C. M. Hesford & Co. Ltd., Roadless Traction Ltd., Taskers of Andover (1932) Ltd., J. Clubley Armstrong Danarm Ltd., T. T. Boughton & Sons Ltd., William Clark & Sons, Massey-Ferguson (G.B.) Ltd., Bruff Manufacturing Co. Ltd., James Donald & Co. (Barblues) Ltd., W. and G. (Challow) Ltd., Gopsill Brown Trading Co. Ltd., Garden Tractors Specialists Ltd., Wolseley Engineering Ltd., William A. Meyer Ltd., Cundeys Ltd., F. W. McConnel Ltd., Tarpen Engineering Co. Ltd., Lundell (G.B.) Ltd., Cooper Stewart Engineering Co. Ltd., Teles Smith Ltd., Lister-Todd Engineering Corporation Ltd., L. Hathaway Ltd., E. Allman & Co. Ltd., Holman Bros. Ltd., Farmfitters Ltd., Helicopter Services Ltd., Plant Protection Ltd., and, of course, the Forestry Commission itself.

Increasing Rainfall

Australia

Rain-making experiments in two adjoining areas of South Australia, verging on the Australian desert, may increase their normal 20-in. rainfall by 10%. Throughout the winter the experiments are to be conducted in turn in the two areas.

Two planes, one an R.A.A.F., DC-3 and the other the C.S.I.R.O.'s own Anson, are being used alternately in seeding suitable clouds with silver iodide smoke. Air crews take the temperatures of the clouds before seeding them to ensure that their tops are of the right degree of coldness to produce rain. About £A1,000 worth of silver iodide will be used each winter.

According to the C.S.I.R.O. Radiophysics Division principal research officer, one-hundredth of an ounce of silver iodide is as effective in one small cloud as 1 cwt. of dry ice. Burners on each aircraft's wing tips burn 4 gal. of an acetone solution of silver iodide hourly. The planes operate mainly at altitudes from 6,000 to 12,000 ft.

Rain should start about 20 minutes after a cloud seeding, to reach a maximum in half an hour and to cease after about an hour. The Adelaide Weather Bureau co-operates in providing forecasts and in tabulating rainfall results.

These methods are believed capable of increasing rainfall by up to 20%, but, as the work is being done in two separate areas, it is not expected that there will be a rise of more than 10% in either. This will enable comparison of rainfall following cloud seeding in one area with natural rain in the adjoining unseeded area.

If a suitable cloud approaches one of the areas at, say, 30 m.p.h., a plane can fly up-wind and seed the cloud 10 minutes before it reaches the area. This would allow time for the silver iodide to precipitate the moisture and form rain drops.

East Africa

Rainfall on the slopes of Kilimanjaro is patchy and uncertain, yet great black rain clouds sail over the land from the 19,000-ft. mountain top day after day.

Last year the West Kilimanjaro Farmers' Association asked their Agricultural Officer for advice about rain-making and Mr. C. M. Taylor, Meteorologist-in-Charge, Central Services, travelled to the district to tell them about simple rain-making. He took with him some small rubber balloons, some 2½-in. long aluminium roll-film containers, some gunpowder, fuses and finely-ground table salt. He described the technique of cloud-seeding by balloon bomb and gave the farmers a demonstration of how to assemble the bombs by filling the container with salt and attaching a fuse pre-set to explode a charge of gunpowder when the balloon reached a certain height. The black rain clouds were seeded successfully and the rain gauge showed an appreciable result, but there is a lot to learn and much skill needed to pick the right cloud at the right time and make rain fall just where it is needed.

International Certification of Seed

The farmers of Europe will in future be able to rely on the qualities and types of seed for grasses and legumes offered for sale, as a result of the O.E.E.C. Certification Scheme adopted by the Council of the Organisation. This will do away with the confusion which has arisen in the past due to differences in nomenclature and methods of certification between countries.

The effect of the new rules and directions approved by the O.E.E.C. is to give herbage seed an International Certificate and a special label issued under the authority of the official seed certifying agencies in O.E.E.C. Member countries.

Copies of these rules and directions are available in printed form and may be obtained on application to the Director of Agriculture and Food of the O.E.E.C.

A Complete Fertiliser—II

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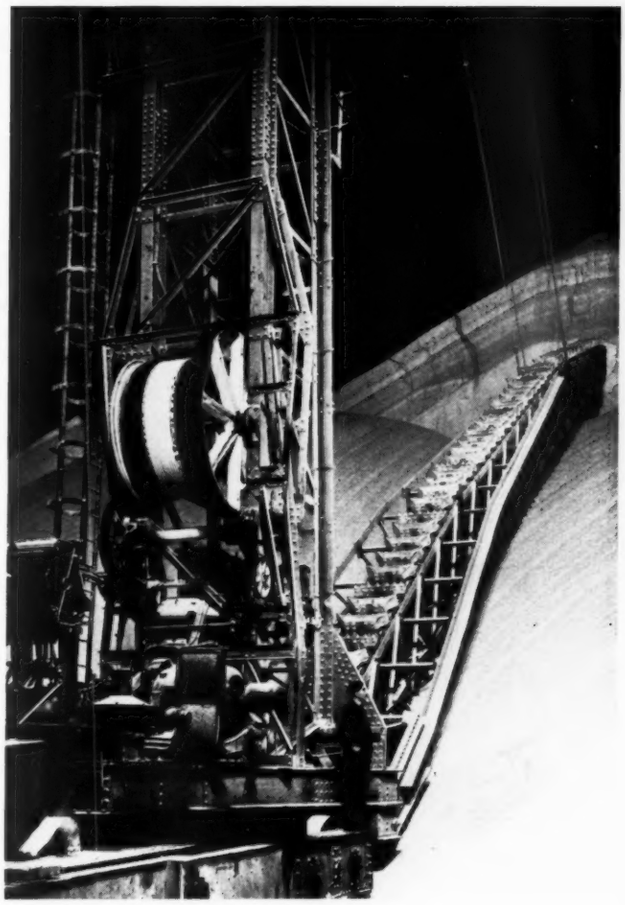
(*Imperial Chemical Industries Ltd.*)

The essential elements of plant nutrition and symptoms of deficiency were dealt with in Part I (WORLD CROPS, 1958, **10**, 317). *Here the question of the application of single nutrients and mixed fertilisers is considered.*



A mountain of fertiliser
The mechanical scraper directs the material towards holes in the floor through which it falls on to a conveyor

A VALUABLE book, edited by V. Ignatieff, was published by FAO under the title of 'The Efficient Use of Fertilisers'.[1] This reviews the whole subject so well, for tropical as well as temperate climates, that only a few major points need be mentioned in a short article on so large a subject.

It is important to realise that the plant food status of a soil, and its fertiliser requirements, are not fixed and constant. They change during periods of years under the influence of the crops grown and the fertilisers applied. In many countries, for example, when the use of fertilisers first began, the soils were very deficient in phosphate and a tradition of heavy phosphatic manuring grew up. As time went on the phosphate deficiency was cured, reserves of available phosphate accumulated in the soil and other deficiencies – usually those of nitrogen and potash – made themselves felt. The fertiliser programme should be adjusted to such changes when they occur, although this is not always done.

It is quite reasonable to supply only those one or two plant foods which are known to be effective, and which repay their cost in immediate crop returns, but it must be realised that the larger crops obtained in this way will tend to deplete more rapidly the soil reserves of the nutrients not applied. Thus, when fertilisers supplying only one or two plant foods are used, the farmer, grower or his advisers should watch for signs of a deficiency of some other nutrient appearing.

A better method, where farmers are prosperous, is to use heavy applications of the nutrient, or nutrients, known to be most effective, whilst at the same time giving moderate dressings of the other major elements – enough to replace what is removed by the crops each year. This is the soundest long-term fertiliser policy and it is being increasingly adopted in the Western European countries. However, one cannot expect an impoverished Asian or African cultivator, or the manager of a plantation which has to show the greatest possible profit, to pay for fertilisers which give no immediate return.

Consequently there is no simple answer to the question whether to use 'straight' (single-nutrient) fertilisers, or mixed or compound (complete) ones. Where a soil has a clear-cut deficiency of some one nutrient, the corresponding straight fertiliser would naturally be used; where two nutrients are known to be low, and one in good supply, then a two-component fertiliser, such as a NK mixture, would be suitable; and where all three nutrients are low or marginal, it is best to use a complete mixture.

Crops vary in their requirements, and so do farmers' practices; for example, in England straight fertilisers are largely used on cereals, whereas complete mixtures or compounds are used on potatoes and sugar-beet. It is a common practice in many parts of the world to give a complete mixture as a 'basal application' when the crop is sown or planted and then to top-dress later with a straight fertiliser that supplies the nutrient that is most effective for the particular crop grown; for example, nitrogen on sugar-cane or maize, or potash on oil palms or coconuts.

Fertiliser ratios

A term frequently used in connection with mixtures and compounds is 'fertiliser ratio'. The ratio is that of the plant foods present in the mixture, usually expressed in a conventional manner in which nitrogen is reported as the element, phosphorus or phosphate as phosphoric anhydride (P_2O_5), and potassium or potash as the oxide (K_2O).

The figures given are generally the percentage of each nutrient as found

in the fertiliser on analysis, rounded off to the nearest half or whole number. Typical ratios for complete fertilisers are 6:12:6 and 12:12:18. The former is a 'low-analysis' mixture, made by mixing ordinary fertiliser materials, such as sulphate of ammonia, superphosphate and muriate of potash; the latter is a 'high-analysis' or 'concentrated' compound fertiliser, made from special materials, including ammonium phosphate, and manufactured in a granular form.

Occasionally fertiliser ratios are expressed as the ratio of two of the nutrients to the third (usually nitrogen) in such forms as 1:2:1 or 1:1:1½. This is simpler to apprehend, but before the mixtures can be used in practice it is still necessary to know their analyses so that the actual rates of plant food application per acre can be worked out. Caution is required because the custom has grown up in some overseas countries of using the ratio of the fertilisers themselves instead of the plant food ratios. Thus a '1:2:1 mixture' might be a mixture made from 1 cwt. of sulphate of ammonia, 2 cwt. of superphosphate and 1 cwt. of muriate of potash. This would have a nutrient ratio of roughly 5:10:15 instead of (as might otherwise be expected) something like 6:12:6.

The question of which are the best fertiliser ratios depends so much on local conditions that it cannot be answered here. It may, however, be observed that there has been a tendency in recent years for the total consumption of plant foods in several countries to change from the old 1:2:1 ratio towards a 1:1:1 ratio. There is much to be said for having 1:1:1 (as, for example, in a 13:13:13 compound) as one of the standard ratios for complete fertilisers. Another useful ratio is 1:1:1½ (or 12:12:18), which supplies the basic needs of crops like potatoes and sugar-beet and can be supplemented with extra nitrogen or phosphate if desired.

A great deal has been said and written in the past about the best fertiliser ratios for different crops and many such ratios have been put forward. It will be appreciated from what has already been said, however, that it is not only the nutrient needs of the crop itself which are important, but also the nature of the soil and the previous cropping and manuring. Consequently, fine distinctions between fertiliser ratios are unjustified and scientific opinion has for a long while advocated reducing the number of different ratios to a minimum and dealing with any special needs of individual soils or crops by supplementary fertiliser applications, including top-dressing. Leading authorities have pointed out that the *rates* of application, in lb. or cwt. per acre, of the plant foods that are most effective with the soil and crop concerned are a more important matter than the *ratios*, as such, that may be present in any mixtures that are used.

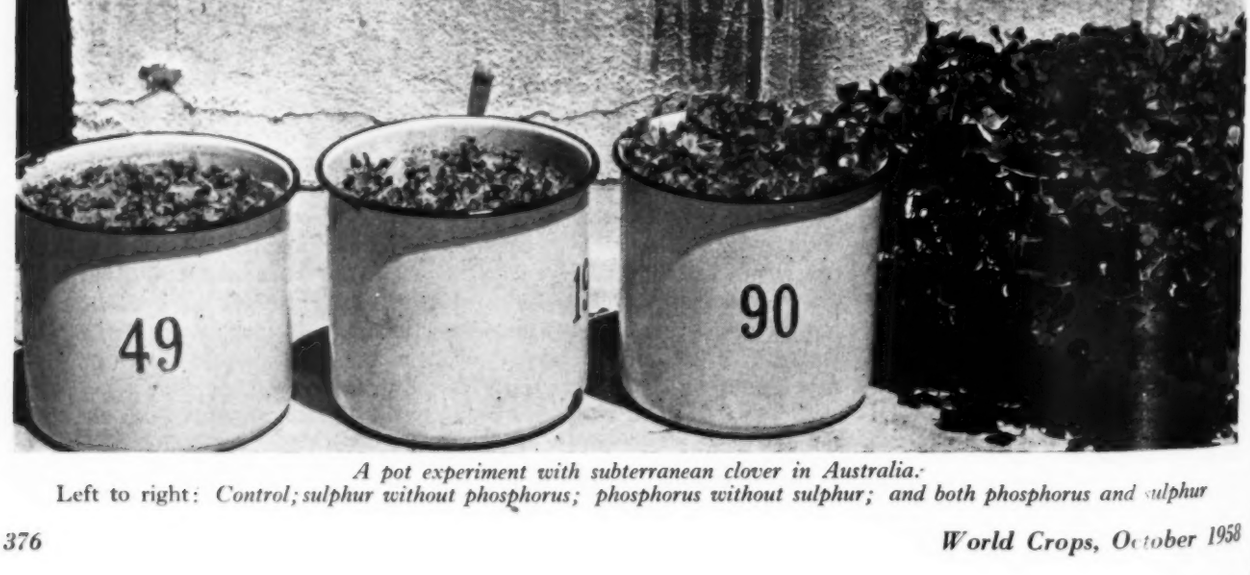
Profit from fertilisers

Where field experiments that give a measure of the responses to different quantities of fertiliser have been done, the direct effects of using fertilisers are easily assessed economically. If a fertiliser, such as sulphate of ammonia, costs £1 a cwt., and if 1 cwt. of sulphate of ammonia per acre produces, as is usual, 2 cwt. of grain per acre, priced at £1 10*s.* a cwt., or an increase worth £3 an acre, then the use of the fertiliser is clearly highly profitable. In practice, allowances must be made for costs of transport, fertiliser distribution, harvesting and so on; even when such allowances are made it is generally found that a farmer can expect a good profit if he uses a fertiliser that produces an obvious increase in the yield of his crop.

The economics of using complete fertiliser mixtures or compounds for general fertility maintenance, *i.e.* of applying plant foods that secure no immediate response, are more difficult to assess. It is, perhaps, best to regard this as a form of insurance, a premium that is paid now in order to avoid having to spend more on fertilisers in the future if other deficiencies develop.

Another problem in using fertilisers is to decide the best rate of application. Strictly speaking, this also is a financial matter; economics apart, the best rate of application would be the one that gave per acre the largest yield of crop of satisfactory quality.

To determine the best rate of application from the economic point of view yield or response curves from accurate field experiments are necessary. They generally show that as the rate of application of a plant food increases the curve for the response to the fertiliser tends to become less steep or to flatten out, an example of the law of diminishing returns. Mathematical methods



A pot experiment with subterranean clover in Australia.
Left to right: *Control; sulphur without phosphorus; phosphorus without sulphur; and both phosphorus and sulphur*

A grassland experiment in Australia. Left foreground: *Control or untreated plot.* Right foreground: 8 *cwt./acre of superphosphate.* Background: *Various combinations of phosphate and sulphate*

can be used to determine the point on the curve at which the extra yield will no longer pay for the extra cost of using more fertiliser.[2, 3] In Western European countries this point is being approached with intensively manured crops, but in most parts of the world the usual rates of fertiliser application are well below the economic optima.

Trace elements

The foregoing discussion applies especially to the 'major' elements, N, P and K, because, as stated, they are the plant nutrients which are most widely needed and which are applied in the largest quantities. However, where one or more of the 'minor' or trace elements are deficient from the soil, similar reasoning will generally hold.

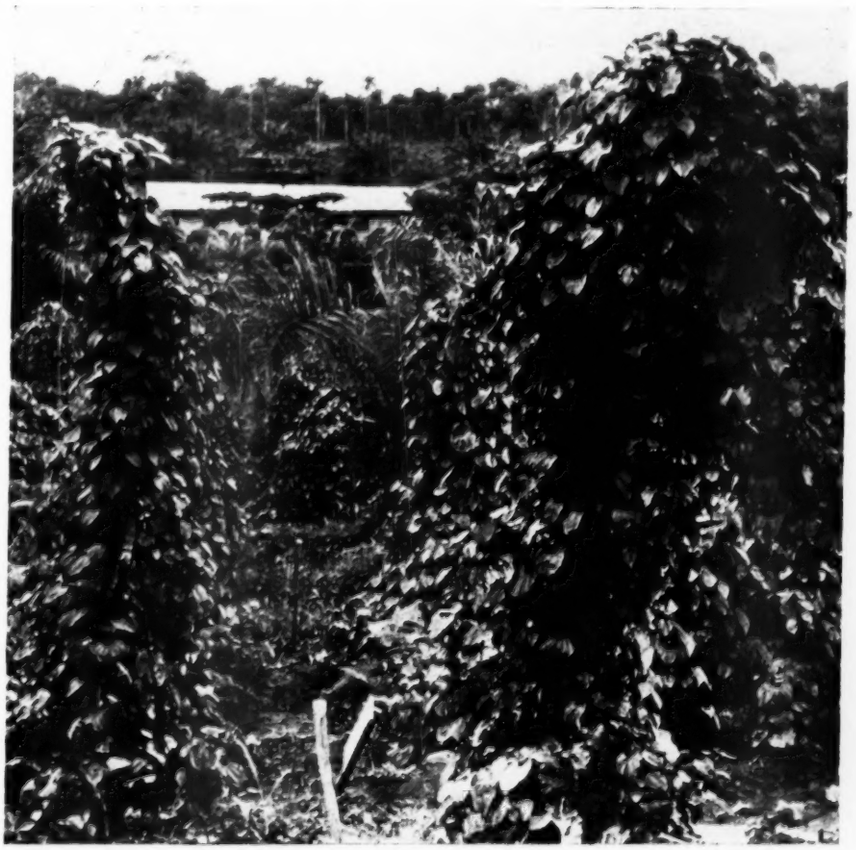
Where severe trace element deficiencies exist their effects may be dramatic, and so equally may be the benefits from supplying the missing elements. When oil-palms or rubber trees that have been suffering from magnesium deficiency are treated with suitable magnesium compounds the conversion of sickly, chlorotic plants into healthy, green ones is very striking. So, again, is the reclamation of great areas of waste or 'desert' land in Australia and New Zealand, achieved by supplying a missing trace element with ordinary fertilisers. Such striking results may cause trace elements to be regarded almost as a panacea and so lead to their being used more widely than is, in fact, justified.

Most soils have actually an ample sufficiency of all the minor elements, so that it is quite unnecessary to apply trace-element mixtures at large as an insurance. Where trace elements are needed they may be needed very badly, and then they must be used to get good crops. It is uneconomic, and may be actually harmful, to apply them where they are not needed.

It should also be remembered that many fertilisers already contain useful amounts of the minor elements. For example, single superphosphate contains a considerable proportion of calcium as well as much sulphur; sulphate of ammonia and sulphate of potash likewise also supply sulphur. Thus the use of any of these fertilisers can cure sulphur deficiency or prevent its appearance.

Superphosphate also contains small amounts of the less common trace elements, as does basic slag. Basic slag likewise provides calcium, silicon and considerable amounts of magnesium and manganese. Chile nitrate of soda contains several useful trace elements, although in very small amounts.

Obviously the trace elements present in ordinary fertilisers must not be overvalued. They help to prevent trace-element deficiencies developing, but they are only worth paying extra for, if the soil lacks one of the trace elements



A yam fertiliser experiment in West Africa. Left: *No fertiliser added.* Right: 480 *lb./acre of NPK mixture* (10-10-20)

they contain – and even then it is usually best to supply the missing element deliberately and separately at a known rate of application.

The best method of applying trace elements varies widely with circumstances and cannot be considered in detail here. Sometimes they are included in standard fertilisers or fertiliser mixtures; while this saves labour, very skilful mixing is needed to secure even distribution and it is best done by the fertiliser manufacturer. Sometimes minor elements are applied separately, like other fertilisers, direct to the soil; sometimes foliar application is used, whereby a dilute solution is sprayed on the leaves of a crop suffering from a deficiency. Special chemical compounds including chelated metals or such proprietary mixtures as ' Fritted Trace Elements ', are also used.

The advantage of applying a trace element separately, and not in a fertiliser mixture, is that the individual element can thus be used where and when required and in the most suitable form. Certain soils, for example, fix trace elements so that plants cannot use them and to supply them in ordinary fertilisers serves no useful purpose. Furthermore, over-doses or too great an accumulation of trace elements are most easily avoided by individual application.

Thus, despite a growing realisation of the importance of the minor elements as well as the major ones, it is still true to say that for most soils and crops an NPK mixture or compound is a complete fertiliser. Even when there is a trace element deficiency and the ' complete ' mixture would seem to be incomplete it is usually best to supply the trace element separately. However, there is some place in modern farming for the careful use of complete mixtures to which trace elements have been added.

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Agricultural Engineering

Mr. Lionel Harper, President of the Agricultural Engineers' Association, recently made the important announcement that a National College of Agricultural Engineering is shortly to be established in England.

Agricultural Chemicals in U.S.A.

Spectacular progress is likely to be made in agricultural aviation in the U.S.A., according to U.S.D.A. Although aircraft are already treating a fifth of the total 410 million acres under cultivation, dispersing chemicals by air is still only in the pioneering stage.

Special planes, designed specifically for releasing either liquid or dry chemicals, will eventually replace the war-surplus aircraft that have hitherto been used in aerial operations. They will be designed for slower flight, shorter take-offs and landings, improved pilot visibility and maximum safety.

Devices for the efficient distribution of the chemicals will also be developed to keep pace with these improvements. Recently a spreader was designed for releasing granulated insecticides, which is a modified version of the conventional dust spreader. Its vanes have been rearranged to give a uniform swath from an altitude of 25 to 70 ft. at 100 m.p.h. and it will release up to 30 lb. of insecticide per acre.

The complexity of the problem facing equipment designers is increased by the speed with which research is producing new and improved agricultural chemicals. As recently as 1948, for instance, all grasshopper control work was done by spreading a wet and somewhat cohesive bait, difficult for aircraft to handle. The following year a dry bran bait was given widespread trial, which was easier to distribute from planes. Then in 1951 oil sprays came into general use. They proved to be even more adaptable to aircraft application, but in each case a change in dispersal equipment in the aircraft had to be made.

More efficient ground dispersing equipment has begun to appear, too. Spray blowers, mist blowers and fog blowers have replaced the older high-volume, high-pressure sprayers in many areas, while boom sprayers have replaced dusters except for certain specific purposes. Here again the rapid appearance of new chemicals complicates the design of dispersing equipment, because some chemicals are abrasive, some are corrosive and others can be dangerous to humans, if not handled properly.

Control of Leatherjackets

Leatherjackets, or cutworms as they are sometimes called, are the larvae of the familiar ' daddy long-legs ' or crane fly. They are legless grubs, long and cylindrical in shape, from 1 to 1½ in. in length, when fully grown. The skin, which is tough and leathery, is brown or greyish-black in colour and closely resembles the soil in which the grubs live for about nine or ten months before becoming mature. They feed chiefly on the roots and underground stems of a wide range of farm crops, but under damp conditions and, particularly at night, they will also feed above ground, cutting off the young plants at soil level.

Leatherjackets are especially prevalent in old pasture land and, when the lea is ploughed, the cereal and flax crops sown are often seriously injured by them during the brairding stage.

If grain crops are attacked, rolling with a heavy roller very early in the morning gives good results, as does also the application of a dressing of nitro-chalk or of nitrate of soda at the rate of 1 cwt. per statute acre. These practices are not, however, adequate to deal with a severe attack. The most satisfactory method is to apply a poisoned bait. This remedy is now generally recommended and is suitable for use prior to or during the progress of an attack in fields of oats, barley, wheat and flax.

Insecticides suitable for the poison bait include paris green, 50% dispersible benzene hexachloride (BHC) and 20% dispersible DDT. The bait is prepared by mixing 1 lb. of the selected insecticide with 28 lb. bran and moistening the mixture with water, or water and treacle. The mixture moistened with treacle water is reputed to be more attractive to the grubs than that moistened with ordinary water. This quantity of the bait is sufficient for one statute acre.

The bait should be scattered evenly over the attacked braird, preferably in dry weather and as soon as possible after an attack is noticed. If rain follows soon after application, the treatment may have to be repeated, but, if successful, the dead grubs should be seen on the surface of the field a couple of days after application.

New Publications

Copper Compounds in Agriculture—and Industrial Microbiology

Published by the Copper Development Association, London. Pp. 117, illustrated. C.D.A. Publication No. 41, third impression. 1957.

This book well achieves the objective of the Association of providing a useful and convenient summary of the uses of copper compounds in agriculture and for other purposes, such as water treatment and textile and timber preservation. Most of the book is devoted to the uses of copper for the control of fungus diseases of crops, at home and overseas. The diseases are well described and recommendations for control are made. The uses of copper compounds in seed treatment and in insect and weed control and short descriptions of copper-deficiency diseases of plants and animals are also included.

The modern grower is much concerned with small-volume application, which is only briefly mentioned in the chapter on spraying equipment. Crop protection methods are continually improving and so far as possible the latest recommendations should be given. Experimental results and uses that have little significance today are frequent (see, for example, the references to the work of Grubb and Sanders on pp. 54-55). These tend seriously to outdate the publication and might well be omitted or replaced by more recent information. The book is attractively produced and well illustrated and may be obtained from the Association on request provided that evidence of genuine interest is given.

J. T. MARTIN

A Profile of the European Market

By H. Th. Vreede. Pp. 160, with maps and diagrams. Amsterdam, Holland: De Twentsche Bank N.V. 1958. For limited distribution.

On March 1957 the treaty for the inauguration of the European Economic Community was signed in Rome and it has since been ratified by six co-operating countries – Belgium, France, Western Germany, Holland, Italy and Luxembourg – and it thus came into force on 1 January, 1958. Overseas territories of these participating countries are associate partners in the Community.

Its purpose is to foster the exchange of goods and services, to put the common resources to the best possible use and to ensure the most effective use of labour. To achieve this purpose there are four main objectives: (1) the establishment of a Common Market with progressive elimination of tariffs and restrictions on the movement of goods, (2) the abolition of barriers restricting the movement of people, services and capital, (3) the harmonisation of national legislation in the field of labour relations and business competition, (4) the founding of a European Investment Bank and the establishment of a fund for professional training and to provide for the mobility of workers in order to minimise the difficulties of adjustment.

The Common Market is to be established in three stages of about four years each, so that gradual integration will take place over the next 12 to 15 years. Another important development will be the attempt to establish a European Free Trade Area, including Britain and most other OEEC countries. In this area it is proposed that the levying of customs duties on internation trade is to be abolished, but participants would retain their own external tariffs with regard to imports from non-participating countries.

These revolutionary changes in the pattern of trade will naturally affect the economics of the participants as well as those of the non-participating countries and it is to meet the inevitable demand for market information that this valuable book of relevant data has been produced. The facts and figures collected from various sources have been carefully digested and are clearly and concisely presented, shorn of excessive detail which is a very common fault in statistical publications in which little attempt is made to edit the vast accumulation of statistics. It is unfortunate that much of the information relates to 1955, but this is inevitable in view of the time lag in the collection and consideration of the data.

The contents are set out under 11 heads. In Section I, Table 4, there is a very useful statement on population density and the use of the soil in various European countries; Section II, Table 6, gives the potential increase in population over the period 1955 to 1970; Section III includes statistics of the production of agricultural crops, forestry products and livestock and of the production of superphosphate and nitrogenous fertilisers in European countries, and also in the U.S.A. In Section IV there is a useful statement in Table 3 on the *per capita* consumption of food, showing Ireland, Denmark and Iceland (in that order) as the greatest consumers of calories, and Iceland, Finland and France as the largest consumers of proteins per head. Section VII is perhaps the most important of all to our readers, as it deals with imports and exports, considered from various angles and including, of course, agricultural machinery and chemicals, though unfortunately without giving anything like adequate details of the movements of individual agricultural commodities and dairy products, except, apparently, under the very general classification of 'food, drinks and tobacco'. This is hardly satisfactory.

The 'Profile of the European Market' covers a very wide field in a very small compass and is well recommended as a useful book of reference, not only to those directly concerned with the complex problems of the European Free Trade Area, but also to students of economics generally.

F. C. COOKE

Cotton

By H. B. Brown and J. O. Ware. New York, Toronto and London: McGraw-Hill Book Co. Inc. 1958. 93s.

This book is the third edition of a work first published in 1927. The present revision is made by Ware, though some chapters are written by other workers. The book ranges over 25 chapters and deals with practically every aspect which cotton presents to the botanist, breeder, plant pathologist, entomologist, chemist and agronomist. It also treats of harvesting, ginning, grading and the trade in cotton. Finally, there is a chapter on

the manufacturing of cottonseed products, closing with a chapter on cotton statistics.

A book of this kind, which purports to be all-embracing and comprehensive, is bound to be somewhat uneven. It is perhaps inevitably biased in its selection of the relevant literature. The authors both hail from the U.S.A. and they naturally ascribe a preponderating importance to the ideas and discoveries of American workers, often at the cost of a somewhat distorted historical perspective. But while the cotton crop is of vast importance in the economy of that country, a great deal of fundamental knowledge of cotton, both as a plant and as a raw material, has also been accumulated in other countries. For example, no mention is made of the classical work of Mason and Maskell on the physiology of cotton carried out in the West Indies; there is no reference to the large amount of first-rate work on cotton done in India during the last quarter of a century; nor would the reader gather from chapter 17 (cotton fibres) that workers at the Shirley Institute (British Cotton Industry Research Association) had contributed greatly to our fundamental knowledge of this subject. The pioneer work of Hancock in Egypt on the genetical aspects of quality is regrettably not mentioned. Notwithstanding these important omissions, the book is one which no serious worker on cotton can afford to be without, and it still remains the standard work on this economic crop.

S. C. HARLAND

Bodenkundliche Untersuchungen

By Iwan Fjodorowitsch Sadownikow, trans. from Russian into German by Dipl.-Landwirt Kurt Knott. Pp. 110. Berlin: Akademie-Verlag G.M.B.H. 1958. 12 D.M.

The author has produced a useful work based on his specialist experience. After dealing with the constituents of the soil, he describes in detail soil survey methods, procedure in research and analysis and the recording of these results on maps. The purpose of such investigations to increase agricultural production and to ensure correct land usage is discussed. The book will be of value to agriculturists, agronomists, colonisation officers and the managers of collective farms; it also is a suitable textbook for agricultural schools and colleges.

Forestry Commission

The National Forest Park Guide to *The Border* has recently been published. This is the most recently formed of the eight National Forest Parks, established by the Forestry Commission in Britain, dating only from 1955. It contains the largest planted forest in Britain, the area afforested having previously been hill land of low agricultural value. Spruces predominate, with pines and larches, but where suitable other trees have been introduced in order to diversify the plantations and their produce. These include hardwoods such as beech and oak, and some of the less common conifers such as hemlock, Lawson cypress, Douglas fir, Serbian spruce and the silver firs.

The Forestry Commission welcomes visitors to the Forest Parks, provided only that they take care not to cause damage. This Guide is full of interesting information about the area and about the work of the Commission presented in an attractive and easily assimilable form. Chapters are included on the history of the Border country, its poetry and legend, geology, vegetation and wild animal life. There is also a chapter on walking, brief descriptions of a selection of walks, and a list of books on many different aspects for those who want to know more. Many useful maps, attractive drawings and a number of excellent photographs together make up an attractive book.

Edited by Dr. John Walton, Regius Professor of Botany in the University of Glasgow, the book is published by H.M.S.O., price 5*s*.

The paper prepared for the British Commonwealth Forestry Conference in Australia in 1957 on the subject of *Exotic Forest Trees in Great Britain* has been published as Forestry Commission Bulletin No. 30. The 165 pages of this paper are divided into three sections: Part I, general considerations affecting exotic forest trees in Great Britain; Part II, detailed information on exotic coniferous trees in Great Britain, including climatic requirements, site requirements, establishment technique, rate of growth and yield diseases and pests, etc.; Part III, information on exotic broadleaved trees in Great Britain. In this section a considerable amount of space has been devoted to the genus *Eucalyptus*. Although it is of no forest importance in Britain, it was thought that the information given on how different species of Eucalyptus behaved in extremely difficult conditions would be useful for foresters in other countries. Published by H.M.S.O., price 17*s*. 6*d*.

FAO Publications

Yearbook of Food and Agricultural Statistics – Production 1957. The present volume contains complete data for 1956, a revision for 1954 and 1955 and data for the post-war average 1948–52. The subjects are dealt with statistically under the following headings: Land Use and Irrigation, Total Population and Agricultural Population, Production of Individual Crops and Livestock, Food Supplies expressed in terms of calories and protein content, the Use of Fertilisers, Farm Machinery and Agricultural Chemicals. Obtainable from H.M.S.O., price 17*s*. 6*d*.

The Owner Cultivator in a Progressive Agriculture. FAO Agricultural Studies No. 39. This paper examines the meaning of owner-cultivatorship and gives a clear picture of alternative methods of land tenure. Obtainable from H.M.S.O., price 2*s*. 6*d*.

Protein Requirements. FAO Nutritional Studies No. 16. This is a report of the FAO Committee engaged in the task of defining protein requirements on the basis of existing scientific knowledge, in order to help governments to plan food production and distribution so that the nutritional requirements of populations are met. Price 3*s*. 9*d*. or $0.75.

Unasylva, Vol. 12, No. 2, 1958, contains an interesting article on ' Forestry in the Soviet Union ' by P. V. Vasiliev.

Also received from FAO, *Plant Protection Bulletin*, Vol. VI, No. 6, of 1958.

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Machinery and Equipment

A Two-man Chain Saw

The *Teles* chain saw, which is powered by a Villiers engine, is designed for felling and cross-cutting at speed. It is fitted with a multi-disk clutch which permits idling and which slips automatically if the saw chain should jam. The blade can be worked at any angle and can be quickly swivelled by a single adjusting lever. This useful implement can be comfortably and easily operated by two men.

A giant laid low by a 'Teles' two-man chain saw

Master of Scrub

It is almost unbelievable the conditions that the *Wilder Rainthorpe* 'Scrub-Masta' can tackle. We saw it in action at the Forestry Machinery Exhibition, where it was used to clear a fire gap through a plantation of young fir trees, and the only limiting factor to its operations appeared to be the ability of the tractor to force its way into the dense mass – a very severe test indeed.

The machine was originally designed for chopping up stubble, but it has since been developed for clearing scrub, heather, bracken, brambles, gorse, blackthorn and other unwanted vegetation. It consists of a rotor driven from a *Fordson* tractor p.t.-o. at 1,500 r.p.m. and carried on a two-wheel trailer. The rotor carries two rows of tines, which are flung out radially under centrifugal force when the tractor is in motion. The height of the rotor is adjustable, so that the tines can actually touch the ground for the complete elimination of all vegetation, or it can be raised to clear the ground by 10 in. when dealing with heavier growths. The tractor used in the demonstration was fitted with a radiator guard and special protection for the driver.

This International TD-9 diesel crawler tractor, equipped with a fireline plough, is being used in the forests of Florida. It has two-way radio fitted

Tractor-mounted Sawbench

The *McConnel* 'All-Work' sawbench can be attached to the 3-point linkage of *David Brown*, *Fordson*, *International*, *Massey-Ferguson*, *Nuffield* and *Allis Chalmers* tractors and carried bodily to the site of operations. On-site sawing saves double handling of the wood and it is claimed that costs can frequently be reduced by 50%. The circular saw blade, of 30-in. dia., will give a 10½-in. maximum depth of cut for ripping and 9½-in. maximum cross cut, at one stroke, with a 15-in. maximum cut if the log is turned between strokes.

Logging

'From Stump to Mill' is the title of a new booklet on pulpwood logging operations offered by *International Harvester Export Co.*, of U.S.A. Exceedingly well illustrated, it describes the use of International crawler tractors with specialised Drott logging equipment.

Helicopters for Agriculture

Helicopter Services Ltd. are specialists in all types of forest and crop spraying. Their machines have been used in Germany for destroying pests in the pine forests and also for spraying the potato fields in East Anglia, where there is a severe outbreak of potato blight. Their machines will obviously have many applications in remote and inaccessible regions overseas for delivering agricultural machinery, equipment and spare parts.

The type of helicopter they use has a perspex cowl giving all-round visibility and two sturdy landing skids for landing in difficult terrain, such as marsh, broken rock or scrubby vegetation. When used for spraying, the spray liquid is put into two hoppers, one on either side of the aircraft. The payload is ¼ ton.

A Lorry-mounted Crane

The HIAB 'Major' hydraulically-operated crane is specially designed for mounting on the chassis of a lorry. There is a 1-ton model with a telescopic jib and a 2-ton model with a folding jib. Either can be fitted to almost any type of lorry without reducing the load area and both cranes can be folded away for travelling. Centrally mounted with dual controls and powered by the

Pruning a fir tree in safety using the 'Safehold' ladder platform

vehicle's own engine p.t.-o., it can be used for loading or unloading timber on either side of the lorry.

Pruning in Safety

All varieties of pine and poplar that are grown commercially are pruned in three successive stages in the first 10 years of the life of the tree in order to produce a long, clean bole, free from knots, to a height of about 22 ft.

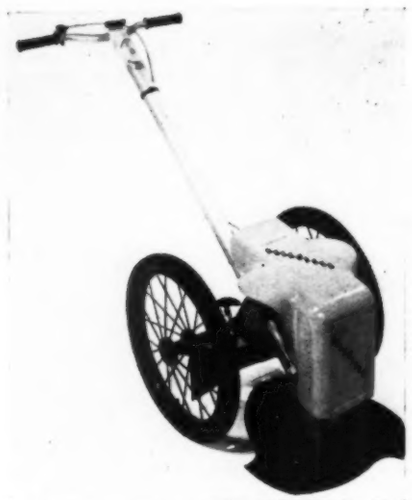
A man of average height, using a short-handled pruning saw, can work in comfort during the first stage – from ground level up to a height of 7 to 8 ft., but above this height in the second and third stages the work is very arduous and time-consuming. The *Stanhay* 'Safehold' ladder platform is the answer. This can be so placed that the operator is level with his work and at all stages of pruning he can work as if on firm ground. This is because the platform and the ladder are clamped firmly to the tree and the platform is rigid and safe and so he can work all round the tree without moving the ladder. The quality of the pruning is improved through the operator being closer to his work and this results in better-quality timber.

The device has, of course, many other applications besides pruning. It could be used for the collection of seed, for the application of foliar nutrients or chemical sprays, for girth measurement at different heights, for the harvesting of oil palm bunches without bruising, for reaching the crown of palms and trees for cross-pollination work and for topping trees.

Bushwhacking

The 'Bushwakka' is a hand-propelled rotary cutter made by *Farmfitters Ltd.* for clearing all types of rough growth, which was demonstrated at the Forest Machinery Demonstration. We manoeuvred the machine over rough and difficult ground and in and around trees without effort. It is well balanced and light enough to be handled for many hours at a time under such conditions without undue strain on the operator, and yet it is powerful enough to deal with really tough growths. Although it only weighs 65 lb., it can be pushed into and cut down a 3-in. fir tree with little difficulty.

The machine has a specially designed cutting blade which rotates horizontally and is actuated by a 75-c.c., 1½-h.p. Vincent engine through a circular clutch. There are no belts or chains and the full power of the engine is delivered without loss to the cutting blade; the centrifugal clutch prevents stalling whenever the blade does come up against an immovable object. There are no projections and the engine is covered by a fibreglass shield, so that the machine can work in difficult bramble growths without hindrance.

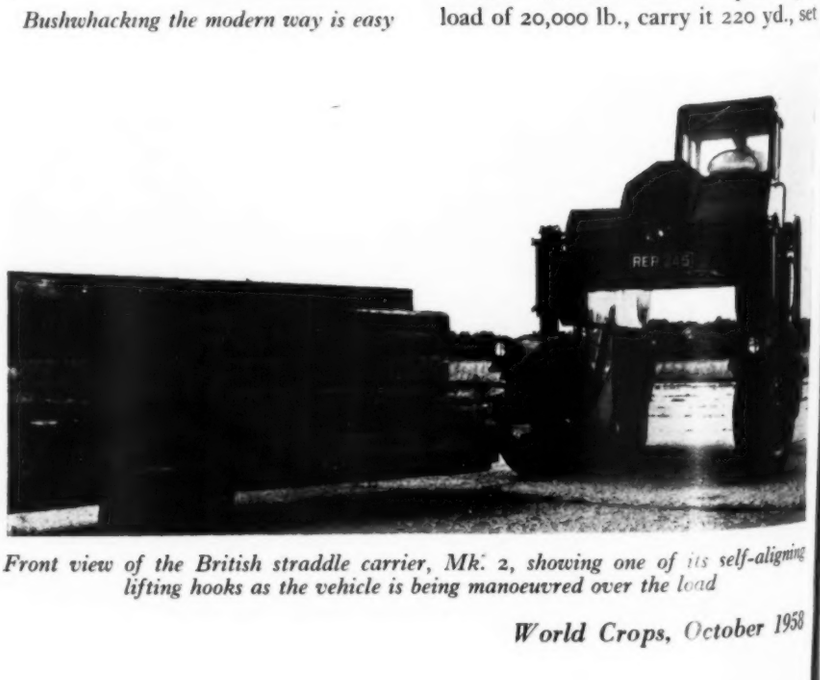


Bushwhacking the modern way is easy

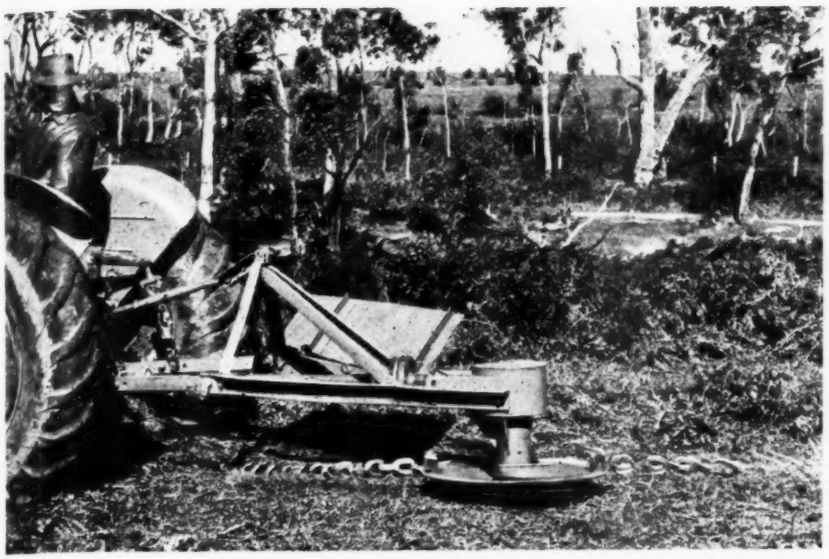
A Remarkable Demonstration

A *British Straddle Carrier*, Mk. 2, of 62 b.h.p. was recently put through its paces in a timber yard at Burt's Wharf, Rochester, and subsequently at an airfield at Rochester, where extremely heavy loads of oil drums, barrels, bricks, fruit crates and pipes were lifted and carried away to a distant site on pallets.

This sturdy vehicle, which has a lifting capacity of 20,000 lb., was used to carry timber up to 100 ft. in length. It carried enormous loads at speeds of up to 30 m.p.h., but was always under perfect control. The demonstration showed that one man can pick up a load of 20,000 lb., carry it 220 yd., set



Front view of the British straddle carrier, Mk. 2, showing one of its self-aligning lifting hooks as the vehicle is being manoeuvred over the load



Tough stalks are battered and severed by the whirling chains of the ' Arthur ' rotary slasher, made by Taskers of Andover Ltd.

it down and return unladen to the starting point, all within 2 minutes.

The carrier was particularly effective over rough ground because its large-diameter wheels exert immense tractive power and make it possible for the vehicle to move swiftly even in difficult terrain. It also has power-assisted steering, which materially reduces the physical fatigue normally associated with the driving of heavy vehicles, and all four wheels are steerable, so giving maximum manoeuvrability in confined spaces. The power-assisted brakes, too, make very little demand on the driver, who has a spacious cab with excellent all-round visibility and with the controls very conveniently arranged.

For Heavy Slashing

The 'Arthur ' rotary slasher is designed for the reclamation of land overgrown with scrub, bracken, gorse, heather or secondary jungle growths, enabling useless land to be converted into useful agricultural land or forest. Its working principle is simple – it consists simply of a saucer-shaped disk to which are attached four heavy-duty chains. When the disk revolves at high speed the chains pulverise all vegetation in their path, clearing a strip approximately 8 ft. wide.

Tree Planting

The ' P-B ' tree planting machine is made by the *Bruff Mfg. Co. Ltd.* for attachment to tractors. It has been tried out successfully on various types of soil from sand to stiff clay, but where

A 16 in. dia. cross-cut circular saw as attached to the Allen motor scythe

the ground is very stony the large cutting disk in front which opens up the ground needs to be replaced by a smaller one. The operator sits on the machine and as it moves forward at not more than 2 m.p.h. he feeds the young seedling trees into the space between the two pressing rear wheels at the required planting interval.

A Useful Conversion

Besides its normal uses in agriculture, which have already been described, the *Allen* universal motor scythe has two interesting applications in forestry and for the clearing up of old orchards and rubber and coconut estates. It can be fitted with a 900-watt D.C. generator and so used for operating an electrically-operated chain saw, or it can be used to power a cross-cut circular saw. The Allen portable sawbench, which is attached by a 'V' belt to the p.t.-o., can be taken to any point where felling is in progress and the fallen trees can be reduced to logs of convenient size. Branches, 6 in. in diameter, can be cut in one pass, but rather thicker timber can be handled by two cuts and a sharp knock.

Bramble Cutting and Heavy Weeding

The *Mayfield* bramble cutter has two cutter bars – one horizontal and the other vertical. The ground-level horizontal cutter bar is 3 ft. wide and will cut stems up to $\frac{3}{4}$ in. in thickness; the vertical one is to deal with the horizontal runners, and even if they are 4 ft. 6 in. from the ground there is a guide to lead them into the knives. A shock absorber is incorporated in the oscillator mechanism and the drive is taken by two ' V ' belts in parallel. This drive is flexible and so protects the engine against possible damage caused by a sudden stoppage.

Such a machine will not only cut down overgrown bramble where the runners are so long that they have re-rooted, but it would be suitable for dealing with thorny growths of secondary jungle, otherwise known as ' belukar '.

A Heavy Duty Winch

Made for use with tractors with hydraulic linkage, the *Hesford* heavy linkage winch can be attached or detached in a few minutes, leaving the tractor free for other work, while the winch is left on its portable stand at the correct height for easy re-attachment, when required. This winch will fit most tractors equipped with 3-point linkage, but, owing to its great power, some of the lighter tractors may require front weights when the winch is being used at full capacity to pull 12,000 lb. It is supplied complete with

The Mayfield bramble cutter and forestry weeding machine has two cutting knives

anchor, guide rollers, compression links, drive shaft and a wire rope 120 ft. long. The rope drum is fitted with self-oiling bearings and the operator is able to take the load smoothly without snatch.

Hauling and Lifting

The *Hathaway* powered winch provides the answer to a multitude of hauling and lifting operations which are time-wasting, arduous and sometimes dangerous when manhandled. Weighing only 190 lb., it is small and fully portable. It has a small, easy-starting petrol engine and the winch has a tractive capacity of 1,300 lb. when moving at approximately 1 ft. per sec. The unit has four folding handles and is supplied complete with 300 ft. of $\frac{1}{4}$-in. steel cable.

For Scrub Clearing and Tree Felling

The 'Sabre' scrub-clearing machine is a tractor-driven rotary cutter which takes the form of a $4\frac{1}{2}$-in. dia. steel tube fitted with a specially designed circular saw blade. The makers, *J. Foster & Co. Ltd.*, supply a range of cutting blades from 100-tooth blades to cut growths up to about 20 in. in dia. to four-cutter slashing blades for growths up to 4 in. in dia.

A New Light Tractor

The new *Massey-Harris* '820' tractor, produced in France, is already in use in Equitorial Africa. The machine is mainly intended for the small farmer but it can also be used economically on large farms.

It has a five-speed gearbox, with a low creeper speed of 1.75 m.p.h., a road speed of 9 m.p.h., two ploughing speeds and reverse. Good ground clearance and the range of implements enables this versatile tractor to carry out nearly every job from ploughing to reaping.

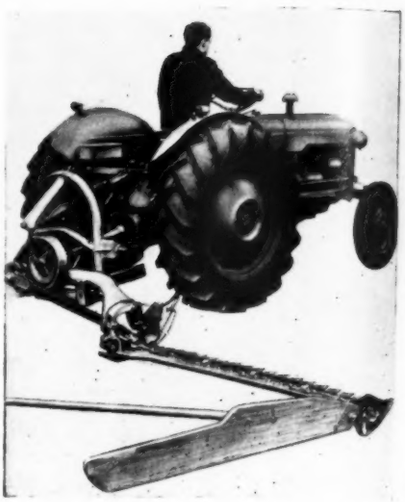
The power unit is a 2-cylinder, 2-stroke, water-cooled diesel engine, which develops 18 to 24 h.p. at maximum r.p.m. This provides sufficient power for a two furrow, 10-in. plough under normal conditions. Independent steering brakes enable tight turns to be made in row-crop work.

A Pocket Crane

The *Rotolift* is a winch or crane which can be carried in one hand. It is a simple lever and chain device which can be used in the most awkward and confined spaces for lifting, lowering, dragging, easing or tightening heavy loads. For dropping a heavy motor gently into position, for dragging a car or lorry out of a quagmire, for tightening a wire fence or for dragging a tree trunk up by the roots, it is just what is wanted. It is a most useful general-purpose tool for the forester and the farm handyman. The smallest $\frac{3}{4}$-ton model weighs only 20 lb. and this astonishing weight-size to power ratio is obtained through a steel chain and ratchet arm with a very smooth action.

A Tractor Mower

The TM 1012 is a new introduction of *Ransomes, Sims & Jefferies Ltd.*, which is equally suitable for category 1 and 2 linkages and is fully mounted. A powerful spring – adjustable for tension – allows the mower to follow the contour of the field very closely and a second spring enables the cutter bar to float on uneven land without bounce. The machine has a 5-ft. cutter bar driven from the p.t.-o. through a 12-in. pulley operating at 981 r.p.m.



Tractor mower model TM 1012 has a 5-ft. cutter bar, is driven from the p.t.-o. of the tractor and is fully mounted

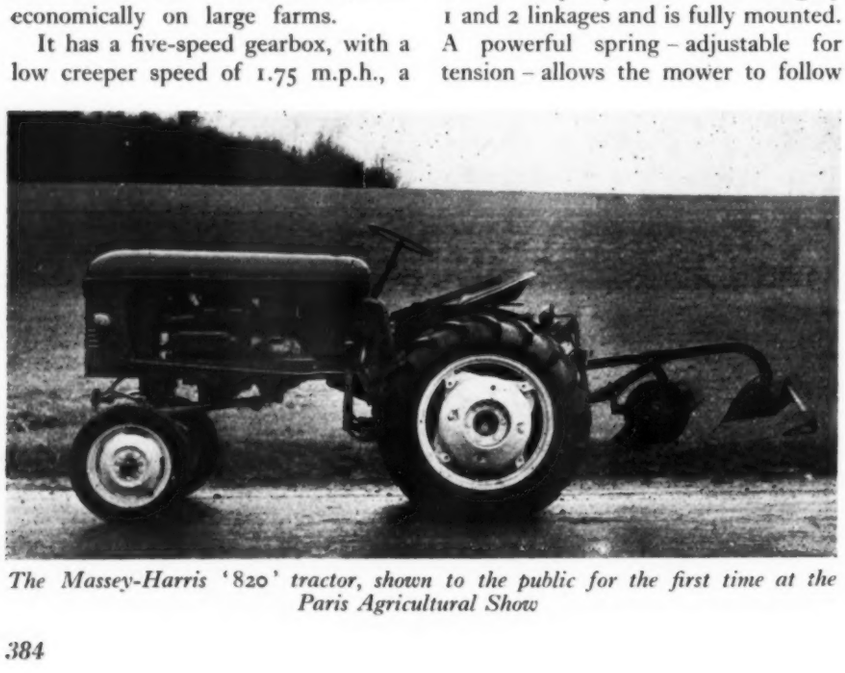
Sawing on Site

A transportable sawbench which can be attached to the 3-point linkage of most makes of tractor is indeed a valuable implement for land clearance operations in forest, jungle or plantation. The 'Arun', manufactured by *Walter A. Wood Co. Ltd.*, can be used on old rubber and coconut plantations for reducing the size of the felled trees and converting them into logs, rails or fence posts on site prior to replanting.

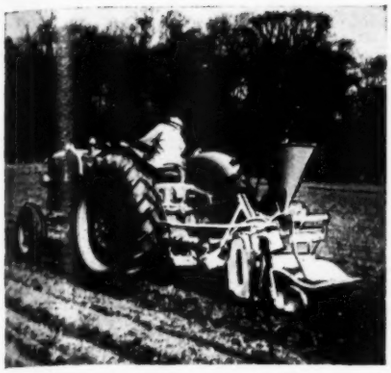
The all-steel bench, carrying a circular saw, is bolted securely to the 3-point linkage of the tractor and so held rigidly in position. There are three sizes of circular saw – 18 in., 24 in. and 30 in.; these give depths of cut 6 in., 9 in. and 12 in. respectively. In all models the working table is the same size – 48 in. × 24 in. – and the machine is fitted with fast-and-loose pulleys and striking gear.

For Loading Bales

The 'Clydebuilt' bale loader can be fitted to the tractor in from 5 to 10 minutes and the main beam of the loader which fits on to the tractor carries the main drive from the p.t.-o. through bevel gears to a 'V' pulley. The main elevator belt is fitted with a tensioning pulley to take up any wear. The implement, which is side-



The Massey-Harris '820' tractor, shown to the public for the first time at the Paris Agricultural Show



The Howard-Allman ' Auchincruive ' soil mixer seen in action

mounted, will pick up bales lying at almost any angle to the line of travel and deliver them to a height of 11 ft. on to either an independent or a towed trailer and stack them five bales high. The machine is made by *Innes Walker (Engineering) Co. Ltd.*

For Eelworm Control

Soil-borne diseases are difficult to control. The injection of volatile materials which penetrate the soil by means of their own vapour have given some success, but suitable volatile materials are generally expensive. Some non-volatile materials are less expensive, but they need to be intimately mixed with the soil if they are to be really effective.

The 'Auchincruive ' soil mixer system links two machines – a *Howard* 'Rotovator' and an *Allman* 'Speedesi' duster, fitted with a booster fan – by first mechanising two applications of a protective dust of various inorganic mercury compounds (1) at the surface and (2) at a depth of 7 in., and then these are thoroughly mixed and incorporated into the soil by the ' Rotovator ' working to 9 in. This system gives the cheapest control of potato root eelworm, because research has shown that an application of 5½ lb. per acre in this way is more effective than even 200 lb. applied on the surface. It is claimed that this treatment will diminish the eelworm population by from 60% to 80% and will increase potato yields by 2¼ tons per acre.

Strip Grazing

It is well known that strip grazing ensures the best use of pasture and makes it possible to carry from one to three more cattle on 25 acres of grassland. Controlled grazing also produces good compact turf with a gradual increase of pasture components of good grazing quality.

Koltec N.V., of Holland, have produced an interesting little booklet on the subject and giving instructions regarding the Koltec electric fencer. They offer a ' mains ' model and a battery model; the consumption of electricity is so small that one 7½-volt dry battery is sufficient for a whole nine-month pasturing season. The system is easily erected and can be moved and re-erected quickly elsewhere and, providing the insulation of the fence wire is properly carried out and the jointing of the wires is correct, the makers state that the unit may serve many miles of wire.

The Eversman RE-TRAK-LUG in fully extended position

Increased Traction

The *Eversman Manufacturing Co.*, of U.S.A., are to manufacture an attachment that increases the traction of wheel tractors. To be known as ' Re-Trak-Lug ', this attachment consists of a strong, welded assembly with eight or ten retractable lugs (which can be extended or retracted as required). It can be attached to the outer rims of the two rear wheels of any popular make of tractor simply by attaching it with bolts. It is available for nearly all sizes of tractor rims of 24 in. and larger.

Use of the attachment makes it possible to work the soil in any season of the year. Whenever the going is muddy and the tractor wheels start to slip and spin the lugs can be quickly cranked out so that they dig into the ground, supplying the added traction needed for pulling the load. For driving on a surfaced road, or in conditions that do not require the extra traction, the lugs can easily be cranked back so that they do not touch or dig into the ground. They can also be set in an intermediate position.

Because traction is applied more equally by both wheels, the attachment saves wear on tyres, transmission and axle, and provides a substantial saving in fuel. In many cases the lugs will eliminate the necessity of installing wheel weights or adding water in the tyres.

For Drilling Wells

A low-cost well-drilling machine, which is simple to operate and yet will bore down to 1,000 ft., has just been announced by the *Warner Danby Corporation*, of U.S.A. It appears to be particularly suitable for lumbering camps, colonisation schemes, plantations, farms and ranches, as it is neither as large nor as expensive as the standard drilling rigs hitherto used.

The ' N-W ' well driller is available in three sizes for producing wells of 4-in., 6-in. and 8-in. inside diameter. The smallest 4-in. model is only 8 ft. high and can be easily carried, even on the back of an animal to otherwise inaccessible sites. It can be quickly set

The ' N-W ' well driller can be used to bore down to 1,000 ft.

The 40-in. ' Agrotiller ', as attached to a Nuffield tractor

up and operated by one man with no previous experience; it can be used in the open or in confined spaces, such as cellars and barns, providing there is sufficient headroom. It will obviously meet a long-felt want.

Drilling is effected through the reciprocating action of an engine-driven cam and a ½-in. wire rope, from which the heavy drill is suspended, and clutches control the drive at 36 strokes per minute. A special device permits the drill-head winch to pay out more wire rope as the drill advances down into the hole.

Rotary Cultivation

Frank Bonser & Co. Ltd. announce that the 'Agrotiller ' has the blessing of four leading tractor manufacturers. There are four models – the 40-in., 50-in. and 60-in. tractor-mounted models and a 70-in. trailer model. The new 40-in. heavy-duty model is specially suitable, because of its reduced width, for attachment to smaller tractors, such as the *Fordson* ' Dexta '. At the same time the machine can also be attached to the more powerful tractors, in addition to the smaller tractor, for which it was designed, and *Morris Motors* have now, after many months of exhaustive tests, approved the 'Agrotiller ' for use with their Nuffield 3 and Nuffield 4 tractors.

Mechanical Weed Control

An increasing number of planters, farmers and horticulturists are coming to the conclusion that weed control is the most important function of ploughing. Such control is important in the case of annual weeds, but doubly so in the case of perennials, such as *Imperata cylindrica* – the scourge of the tropics, known variously as 'Iiluk' in Ceylon, ' Lallang ' in Malaya, 'Alang-Alang ' in Indonesia and ' Cogon ' in the Republic of the Philippines. The standard method of getting rid of this troublesome weed is ploughing followed by repeated disk-harrowing. By ploughing, the underground roots or rhizomes are brought to the surface and exposed to the sun; the harrowing breaks up the reversed clods left by the plough and so exposes the roots to the sun. Repeated ploughing gradually reduces sexual reproduction through the aerial parts of the weed (with subsequent wide dispersal of the air-borne seed) and in time the Illuk is replaced by other grasses.

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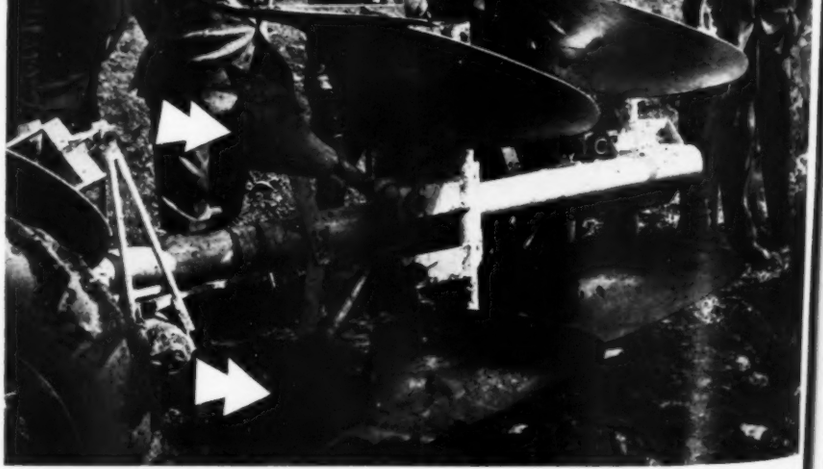
It follows that *a plough specially designed to bury the whole of the surface soil and weeds to the full depth of ploughing will contribute to much more effective weed control* than the ordinary standard plough, which produces clods with an exposed edge, since weeds can easily re-establish themselves from the edge of the reversed clod. This will apply equally to weed control in temperate regions in Europe and America.

Total burial of surface growths can be achieved in a single operation by means of the new *Bomford* reversible plough, which is fitted with a small skim plough which travels slightly in advance of the main ploughshare. The skim ploughs to a depth of 5 in. and turns over a shallow sod, while the main plough goes down to a depth of, say, 11 in. and turns over a larger sod with the vital edge removed, and this completely covers the smaller sod. The complete effectiveness of this simple principle was seen in a recent demonstration in which both single-furrow and two-furrow reversible ploughs, mounted on a *Massey-Ferguson* ' 35 ' tractor, were seen in action in a field of old broccoli, in which there was a large amount of weed growth, including muckweed which was up to 2 ft. 6 in. long.

The special design of the Bomford reversible plough makes it possible for the skims to be set well forward from the mouldboard and still allow plenty of room in front of the skim itself to enable it to do its work properly without choking, particularly when ploughing in straw and other top trash. The main problem in giving such clearance in a two-furrow plough is to keep the weight down and still have a sturdy plough. This has been achieved by tubular construction, which also does away with need for hydraulic reversing equipment. The simple reversing device, which is provided instead, was most effective.



Mr. D. R. Bomford discussing the special features of the Bomford reversible plough. Two of the skim ploughs can be seen; the other two are hidden by the forward ploughshares

Agricultural Chemicals

And Supplies

Plant Nutrients

The supply of plant foods in the soil is reduced each time a crop is harvested. Each grain of corn, every coconut or pod of beans develops to maturity on nitrogen, phosphorus and potash (plus certain other secondary and trace elements) which it extracts from the soil. The following table indicates the approximate amounts of nutrients removed by a single harvest of some of the major crops of world agriculture:

Crop	Acre Yield	Nutrients Removed (lbs./acre)		
		Nitrogen	Phosphorus	Potash
Corn ..	100 bu.	166	59	90
Rice ..	80 bu.	79	25	82
Wheat	40 bu.	69	27	41
Cotton	1,500 lb.	81	29	47
Sugar Cane ..	30 tons	96	54	270
Coconuts	..	66	27	123

To maintain fertility, these elements must be put back in the soil to feed succeeding crops. This is the job that fertilisers do. They are formulated to contain essential elements singly or in any combination necessary to re-build and maintain soil fertility.

The three major elements needed for plant nutrition all have important roles: Nitrogen gives the dark green colour to plants; produces rapid growth; increases yields of leaf, fruit or seed; improves quality of leaf crops; increases protein content of food and feed crops; and feeds soil micro-organisms which decompose organic matter in the soil. Phosphorus stimulates early root formation and growth; gives rapid and vigorous start to plants; hastens maturity; stimulates blooming; aids in seed formation; and builds winter hardiness in autumn-sown grains and hay crops. Potash imparts increased vigour and disease resistance to plants; increases plumpness of the grain and seed; aids in the formation and transfer of starches, sugars and oils; produces strong, stiff stalks; and imparts winter hardiness.

Formulators and growers all over the world draw on *Monsanto's* broad selection of fertiliser materials in continuing efforts to expand food production for an ever-increasing world population.

For Chewing Insects

Estonate W-50 is a free-flowing, wettable powder, containing 50% of DDT, together with other ingredients to ensure its effective application and retention. This formulation, which is manufactured by the *American Potash and Chemical Corporation*, is primarily for the control of various species of chewing insects on vines, on fruit and nut trees, and on potatoes and sugar-beet.

Reader Service

For further information on any item reviewed in this issue please write to:

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World Crops,
Leonard Hill House,
Eden Street, London, N.W.1,
England

Autumn Grass and Early Bite

To produce an abundance of autumn grass, generous fertiliser treatment is necessary, the essential fertiliser being nitrogen. Nitrogen should be applied either at the rate of 3 cwt. of 'Nitro-Chalk' per acre, or 2 cwt. of sulphate of ammonia per acre; if a compound is required, CCF should be used instead at the rate of 4 cwt. per acre.

The time of application will vary, according to district, from late-July to mid-August, but, in recent years, many farmers have found that there is a good response to fertiliser nitrogen on leys – especially those based on Italian ryegrass – as late as mid-September.

Autumn is also the time of the year to start thinking about next year's early bite. Selected fields should be rested to give the grass a chance to develop strong roots and new shoots before winter sets in. Any deficiencies of phosphate, potash and lime can be made good now by the application of basic slag, muriate of potash and ground rock limestone or lime.

A useful brochure on the subject of 'Good Grassland Management' may be obtained from *Imperial Chemical Industries Ltd.*

Three-in-one

The introduction of a new product called 'Sistan' by *Plant Protection Ltd.* for sterilising soil in greenhouses represents an important advance in the science of pest control, for it enables plant disease, eelworms and weed-seeds to be treated in one operation with one chemical.

It is well known that soil sterilisation is an essential operation where tomatoes are grown year after year in the same soil. The new product kills the spores and mycelia of *Verticillium*, *Fusarium* and *Didymella*, and is particularly effective against *Colletottrichum*, which is usually associated with 'corky root' and on which formaldehyde has little effect.

Furthermore it has proved very successful against Root Knot Eelworm and has also given good results against Potato Eelworm attacking tomatoes . . . and finally it has been found that soil which has been treated with this chemical is freed of weeds, because germinating seeds of weeds are killed during the treatment.

'Sistan' can be applied either by diluting it and watering on to the soil, or by injecting the concentrate into the soil; the important point is that the surface of the soil must be sealed immediately afterwards to prevent the vapour from escaping. This interesting new product is at present only available to the home market and is not being sold overseas.

Dry Rot, Woodworm and Termites

The types of fungi which attack timber vary with the conditions and the climate: *Merulius lacrymans* is the true dry rot; *Poria vaporaria* is responsible for the decay of softwoods in buildings, such as joinery, panelling and skirting boards; *Polystictus versicolor* is the most prevalent cause of decay of hardwoods out-of-doors in Britain and *Polystictus sanguineus* in the tropics; and *Lentinus lepideus* attacks sleepers and telegraph poles.

The furniture beetle, *Anobium punctatum* is a common timber pest which attacks structural timber, joinery and plywood; the death watch beetle, *Xestobium rufavillosum*, probably the best known of all the wood-borers, lays its eggs in cracks in hardwood, preferably in timber pre-digested with a fungus; the house longhorn beetle, *Hylotrupes bajalus*, causes serious damage to softwoods, but there are no outward signs – the wood may look quite sound externally and yet be hollow; and finally there is the woodboring weevil, which only attacks timber, actively infected with either wet rot or dry rot.

For the eradication of most forms of timber decay, it is thus obviously essential that the preservative should be both highly fungicidal and highly insecticidal, and it should have a residual effect which should prevent further attacks on the treated timber.

Protim, a triple-action wood preservative, contains dieldrin as well as chlorinated phenols and it may be used either as a fungicide against dry rot and other fungal attacks or as an insecticide against woodworm and termites.

Plastic Mulching

Commercial vegetable and fruit growers can expect significant increases in yield and considerably earlier crops by the use of a black mulching film, made from *Bakelite* polyethylene. In a series of trials, mulched potatoes yielded 250 lb. per acre, against a yield of only 150 lb. unmulched; mulched rows of cabbages produced 81 lb. as against 20 lb., cucumbers 80 lb. against 24 lb. and tomatoes 56 lb. against 36 lb.

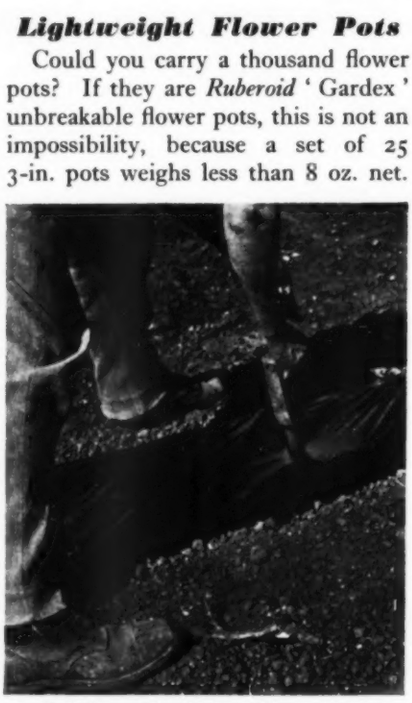
This mulching material is a thin sheet of black film made from Bakelite polyethylene, used in appropriate widths – generally 2 to 4 ft. – depending on the type and size of plants. A shallow trench is made along each side of the row and the length of film is laid, so that the edges drop into the trenches; the soil is then replaced to hold it firmly in position. Slits are made in the film at appropriate intervals, either to facilitate planting seedlings or seeds, or, if plants are already rooted, so that their leaves can be drawn through the material.

The film is claimed to keep the temperature of covered soil some 5°–10° higher than uncovered soil; as a result seeds germinate more quickly and the plants grow readily because of the increased nitrification and extra soil warmth. The film also reduces crusting and packing of the soil, which in turn reduces seed rot; it prevents the growth of weeds and obviates diseases caused by plants being spattered with soil-laden water.

Watering is not normally necessary, as the soil beneath the mulching film remains soft and moist, but in abnormally dry conditions, watering can be done between the mulched rows or on porous soils by furrow irrigation. Black polyethylene can be expected to stand about four years' constant weathering; thus it can be left in position from season to season and this does away with the need for reploughing.

Lightweight Flower Pots

Could you carry a thousand flower pots? If they are *Ruberoid* 'Gardex' unbreakable flower pots, this is not an impossibility, because a set of 25 3-in. pots weighs less than 8 oz. net.



A Bakelite polyethylene film shown in position on a seedbed. The plastic mulch is being pierced with a dibber, after which the bean seed in the man's left hand is inserted

This means that a hundred or more pots can be carried easily in one hand. This is an innovation of immense importance, not only to horticulturists and commercial growers in Europe, but also to tropical agriculture, in which they will find many useful applications in research stations, agricultural trial grounds and botanical gardens. But this is not all, they will be required in immense quantities in the nurseries of tea, rubber, cocoa and tobacco estates, and even on coconut plantations.

Those who are aware of the size of a single coconut seed will certainly want to know how it will be possible to use these pots on a coconut estate, and the answer is for the establishment of a cover of green vegetation on a sterile sandy soil. The nitrogenous cover crop will first of all need to be established in individual pots from seed, cutting, or seedling at a central point, where they can be lightly shaded from the sun and regularly watered, and then, when they are ready, *i.e.* after say 10-12 weeks, they can be planted out in the field, complete in the original special soil, thereby eliminating all risk of root damage or disturbance.

Before planting out, the site should be well-watered, then a hole deep enough to take the pot should be opened, the bottom of the pot should next be removed and the plant placed in position. The makers recommend that the rim of the pot should be ½ in. above the level of the soil to act both as a barrier to insect pests, *e.g.* termites, and as a water trap. Some watering will be necessary during prolonged drought.

It is well known that it is not at all easy to establish a cover crop in a hot, lifeless sandy soil and some failures are only to be expected, so it will be advisable to place a pot in the ground between every two palms; this means that a 1,000-acre estate will need 150,000 pots to ensure the effective establishment of a cover of green vegetation, which will not only cool the soil, but will also fix atmospheric nitrogen and, if the cover is regularly slashed, will build up the organic content of the soil, which is so rapidly depleted under tropical conditions. The result will be larger yields of larger nuts and reduced crop fluctuations; thus the cost of the 'Gardex' pots will be returned a hundredfold.

World Crop Reports

Decline in Cotton Production

INTERNATIONAL REPORT

Cotton

World cotton production in 1957–58 is now estimated at 39.8 million bales (each 500 lb. gross weight). This is 1.6 million bales less than in 1956–57, and 2.9 million less than the record production of 42.7 million bales in 1955–56. The decline was chiefly in the U.S.A., the U.S.S.R., Sudan, Turkey and Spain. On the other hand, production was higher in many countries, including China, Mexico, Egypt and India.

World production, excluding the U.S.A., is estimated at 28.8 million bales in 1957–58, compared with about 28 million in the two previous seasons. The drop in the crop of about 0.5 million bales in U.S.S.R. was because of adverse weather.

The *U.S.* crop this season was 2.3 million bales less than in 1956–57 because of lower yields and a 13% drop in harvested acreage. Final ginnings indicate a 1957 crop of 11 million bales, compared with an average of 13.7 million in the 1946–55 period. Despite generally unfavourable weather, yield per harvested acre was 388 lb., the third highest on record. However, the grade of the crop was materially reduced. The acreage under this crop in 1957 in the U.S.A. was 13.6 million acres, the smallest since 1878. This is explained by the fact that 3 million acres have been taken out of production under the Soil Bank programme. The 1958 acreage allowance is to be raised to 17.6 million acres.

El Salvador's 1957-58 cotton crop is estimated at a record 157,000 bales (500 lb. gross). This is 15% more than the 137,000 bales grown in 1956–57, and is 18% higher than the 1955–56 crop of 133,000 bales. The increase is attributed to slightly larger acreage, continued improvement in cultural practices, and favourable weather.

There were 99,000 acres planted to cotton this season, compared with 95,000 acres in 1956–57, and 113,000 acres in 1955–56. Because of large stocks of cotton, limited farming land, and strong competition from other crops, the area planted to cotton is expected to level off at around 100,000 acres in the next few years.

The Guajira, arid and sparsely inhabited peninsula in the extreme north-east corner of *Colombia*, is the newest cotton-producing area in that country.

The Cotton Institute of Colombia has been stimulating production in this area for the past two years by providing technical help and production loans to farmers. The area planted to cotton in 1958–59 is expected to show a sizeable increase over the 1,000 ha. (2,470 acres) in 1957–58.

A National Cotton Commission has been established in *Costa Rica* to study and recommend any measures necessary to resolve the country's surplus cotton problem. Local production of cotton has been increasing rapidly in recent years and is now greatly in excess of the limited needs of the small Costa Rican textile industry. It is estimated that the accumulated cotton surplus over domestic requirements will amount to approximately 35,600 quintals in 1958. The cotton surplus problem is further complicated by the fact that locally grown cotton is not graded in any way and, in addition, is reported to be of low quality.

The 1957–58 cotton production in *Peru* is now estimated at 499,000 bales from an area of 544,000 acres, compared with 494,000 bales from 556,000 acres in 1956–57. This is an increase in production of 1%, although acreage declined by about 2%.

All of this year's increase was in the crop of Tanguis cotton, which rose to 412,000 bales, compared with 392,000 bales in 1956–57. This increase was attributed to generally favourable growing conditions, more effective cultural practices and improved methods of insect control. Less favourable growing conditions and insect damage caused Pima and Karnak production to decline from the high level of 107,000 bales in 1956–57 to 87,000 bales this season. Production of Pima and Karnak in the 1958–59 season, harvested principally during August and September, is tentatively estimated at 95,000 bales.

Substantial production increases occurred in *Mexico*, *India* and *Egypt* and record crops are expected in *Guatemala*, *Argentina*, *Nigeria* and *Tanganyika* because of higher acreage and good weather, and in *Syria* because of better yields. Improved yields per acre have more than compensated for acreage declines, so that production is larger than a year ago in *Brazil*, *Pakistan*, *Syria*, *Greece* and *Nicaragua*. Lower production is reported for *Sudan*, *Turkey* and *Spain* because of lower acreage and less favourable growing conditions than a year earlier.

Present indications are that cotton plantings may increase in many countries in 1958–59 because of agricultural development programmes already under way, continued government aids to cotton production, expanding mill facilities in cotton-producing countries, and slightly higher prices for upland cotton than a year ago.

REGIONAL REPORTS

China

In the provinces of Kwangtung, Kwangsi, Yunnan and Kiangsi the main winter crop areas, good harvests of *wheat*, *beans*, *sweet potatoes* and *rapeseed* are reported. Total output is estimated at 2.5 million tons. In Chekiang the rape crop is estimated at 100,000 tons and good crops of barley, wheat and beans are also claimed. The area sown to potatoes and sweet potatoes this year is said to have been increased by 3.6 million ha. A big increase in the *tobacco* crop is forecast. The province of Shantung, which accounts for 40% of China's *groundnut* production, plans to harvest 1.5 million tons of groundnuts in 1958.

In Honan, the most important wheat-growing area, total output is claimed to be 8.5 million tons, double that of last year. Shantung expects an increase in wheat production of 30% In Shensi the crop is estimated at 2.5 million tons, a 50% increase. Chekiang's harvest of wheat, barley, beans, peas and potatoes is reckoned to amount to 1.2 million tons, twice last year's figure. Even in Hopei, a climatically difficult area, an excellent wheat harvest is reported despite drought. This year's rapeseed harvest amounts to 1.44 million tons, an increase of 60%.

The spring *tea* crop in the five major tea-growing provinces is reported to be 45,000 tons; in Anhwei alone a crop of 26,000 tons is expected.

Syria

Recent reports from Syria confirm earlier forecasts of a small *grain* harvest in that country. Preliminary estimates place the current wheat harvest at about 20 million bushels, 40% less than 1957 production. The barley crop is down even more sharply; the present estimate is only 25% of the large outturn last year. Both acreage and yields are down significantly.

Shortage of rainfall together with prematurely high temperatures caused deterioration of the grain crops, which had got off to an excellent start. Damage to barley was especially heavy on submarginal lands of al-Rud, but low yields are reported for both barley and wheat over much of the country. Lack of subsoil moisture caused considerable loss.

Chile

Production of the principal Chilean crops in 1957 (1956 figures in brackets) was as follows:

	Metric tons	
Wheat ..	988,430	(1,029,890)
Barley ..	98,010	(101,340)
Oats ..	111,870	(98,860)
Rice ..	82,620	(53,640)
Potatoes ..	635,510	(695,430)
Maize ..	100,030	(140,430)
Beans ..	81,750	(75,200)

Ecuador

The *maize* crop in Azuay Province, central Ecuador, was badly damaged because of dry conditions; there was little rain in February, although this is normally the rainy season there. Northern farms, however, were not seriously affected.

Heavy rains in the coastal area benefited the *rice*, but hampered *banana* cutting and shipping. They intensified the need to speed up control of Sigatoka disease.

Another development in February was the appearance of caterpillar plague on some banana plantations. Texaphane bags and spray were ordered immediately and growers hoped this quick action would prevent serious crop damage.

Despite these unfavourable developments in the banana industry, coastal agricultural prospects were generally encouraging. Heavy shipments of *cacao* were reported at Guayaquil, and some newly developed *coffee* plantations have started producing for export. Production of both cacao and coffee are expected to exceed last year's crops.

Paraguay

Sugar production at 29,000 metric tons to 7 January has broken all records. The Government has authorised credits up to a total of Gs. 32 million (approximately £100,000) to the sugar mills for machinery repairs and re-equipment in an effort to raise production next year to 35,000 tons.

Plagues of ' aquatic weevil ' in the rice fields are being so successfully fought with aldrin that the use of this insecticide has been made compulsory for next season.

Edible *vegetable oil* production in 1958 is expected to cover domestic needs and to allow some palm oil to be exported. Groundnut and cottonseed oil alone are expected to account for some 4,000 tons.

Wheat harvested in the district of Encarnacion up to Christmas was 850 metric tons out of a total expected of 4,000 tons. Some difficulty was being encountered because of the inexperience of the harvesters, which has led to inefficient handling and some deterioration.

Costa Rica

It is estimated in local *coffee* circles that the current 1957–58 crop will amount to a record-breaking 850,000 quintals (1 quintal = 100 lb.) or more. The previous record crop was that of 1954–55, totalling 738,441 quintals, which was almost equalled by the 736,883 quintals from the 1956–57 crop.

England and Wales

Excessive rainfall at the beginning of July caused waterlogging and storm damage over a considerable area of Eastern England as well as actual flooding of some 20,000 acres in Lincolnshire, Yorkshire and scattered areas in Nottinghamshire, Northamptonshire and elsewhere. Except for a short period of warmer and mainly settled weather during the first week, the rest of the month was changeable, with thunderstorms, bright sunny periods and at times heavy rain.

Wheat was generally satisfactory, although ' take-all ' was reported from many districts, and there were some reports of mildew. Heavy rains caused lodging in several areas, but on the whole the crops were standing up well.

Barley promised well despite extensive lodging and the harvesting of some autumn-sown crops was begun. Mildew and ' take-all ' were reported from a few districts and in some eastern areas large patches had been killed by flooding and waterlogging in heavier land. The yield is expected to be 24.7 cwt. per acre, as compared with a five-year average of 23.1 cwt. and a yield of 22.3 cwt. in 1957. Reports on *oats* were variable. Many crops were promising well, but had been damaged by storms, and there had been considerable lodging. Mildew and some damage by frit fly was reported from a few areas. *Mixed corn* and *rye* were generally satisfactory. *Beans for stockfeeding* were not podding well. There were some reports of black fly, and 'chocolate spot' was widespread in many areas. *Peas for stockfeeding* had made excessive haulm growth and podding had been unsatisfactory in some areas; there had been losses of crops through flooding and waterlogging.

Weather conditions made the lifting of first early *potatoes* slow and difficult in many areas, and in some districts blight attacked crops where liftings were delayed. The yield per acre was estimated to be 6.3 tons per acre, as compared with a five-year average of 5.6 tons. Second early and maincrop varieties had made good growth, but blight was spreading in many areas and in some eastern districts crops had rotted in flooded and waterlogged land.

Crops of *sugar-beet* and *mangolds* were good, but in some areas had been affected by waterlogging. *Turnips and swedes* had made good growth, but some damage by diamond back moth was reported from some northern districts. *Kale* had germinated well and was strong and healthy. Weeds were prevalent in all root crops.

Except in a very few areas, the harvesting of *corn* had not begun. *Haymaking*, delayed by the weather conditions, was not yet completed. Crops were heavy, but on the whole had been harvested in poor condition.

Acknowledgement is made to *For. Crops & Mark.* and to *Spec. Reg. Inform. Services* for much of the information contained in the above reports.